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ISSN 0038-3872

SOUTHERN CALIFORNIA ACADEMY OF SCIENCES

BULLETIN

Volume 105 **Number 1**

BCAS-A105(1) 1–42 (2006) **April 2006**

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BOOKS OF INTEREST

Floating Islands: A Global Bibliography, with an Edition and Translation of G.C. Munz's *Exercitatio academica de insulis natantibus(1711)* by Chet Van Duzer

Hardcover, 6 x 9, 428 pages with indices and 24 illustrations
ISBN 0-9755424-0-0 $44.95. Cantor Press

This book is a unique treasury of information about one of nature's marvels: floating islands. The bibliography contains more than 1800 citations of books and articles in twenty languages on the subject; the entries are annotated and cross-referenced, and there are both thematic and geographic indices. All aspects of floating islands are addressed, including the formation of floating islands, the causes of their buoyancy, their role in the ecology of lakes and wetlands, their flora and fauna, their role in the dispersal of plants and animals, and methods for controlling and managing them. Works are also cited on artificial floating islands used for agriculture, human habitation, wildlife habitat, and improvement of water quality; and floating islands in literature, myth, and legend. The book includes the text and English translation, with detailed notes, of G.C. Munz's rare 1711 thesis on floating islands, Exercitatio academica de insulis natantibus, as well as photographs of several floating islands.

The Salton Sea; Geology, History, Potential Problems, Politics and Possible Futurues of an Unnatural Deert Salt Lake. Larry C. Oglesby

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Bull. Southern California Acad. Sci.
105(1), 2006, pp. 1–16

An Annotated Bibliography of References to Historical Distributions of Pronghorn in Southern and Baja California

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Abstract.—Recent pronghorn (*Antilocapra americana*) translocations to southern California and the establishment of captive populations of endangered desert pronghorn have revived interest in the historical occurrence of pronghorn in the Californias. Adding to this interest is the recent widespread replacement of coastal sage scrub vegetation in southern California by annual grasslands more favorable to pronghorn. We have searched the scientific and popular literature, as well as museum collections, to locate pronghorn antelope occurrences from below San Francisco Bay southward through the Baja California peninsula. Our results show that pronghorn were widely distributed, and often abundant, on nearly all of the plains and valleys on both sides of the Coastal and Peninsular ranges to at least as far south as the Magdalena Plain.

Although the U.S. Geological Survey lists more than 30 "Antelope" place names in California south of Parallel 38° North,[6] pronghorn were extirpated from southern California prior to 1950, and the species is now endangered in Lower California (O'Gara and Yoakum 2004). Then, beginning in 1987, translocated pronghorn were reintroduced to San Luis Obispo, Kern, and Los Angeles counties in southern California (Koch and Yoakum 2002). Captive populations of the endangered *Antilocapra americana peninsularis* in Baja California Sur and *Antilocapra americana sonoriensis* in southwest Arizona have also been established with the intention of eventually restoring desert pronghorn to historic habitats. These efforts, at least some of which appear to be successful, coupled with the recent replacement of large areas of coastal sage scrub by annual grasslands more conducive to pronghorn (Weislander 1934; Minnich and Dezzani 1998) prompted us to aid in the evaluation of additional releases by documenting the historic occurrences of "antelope" and *berrendos* in southern California, Baja California and Baja California Sur.

Methods

Contacted museums included the American Museum of Natural History in New York (AMNH), Natural History Museum in London (BMNH), California Academy of Sciences (CAS), Carnegie Museum of Natural History (CM), Field Museum of Natural History (FMNH), Natural History Museum of Los Angeles County (LACM), Museum of Comparative Zoology at Harvard (MCZ), Museum of Vertebrate Zoology (MVZ), San Diego Museum of Natural History (SDNHM), Universidad Autonoma de México (UNAM), U.S. National Museum (USNM), and Burke Museum of Natural History at the University of Washington (UWBM). Literature sources were sought in both the popular and scientific literature giving the approximate dates and locations of pronghorn observations in southern California and lower California prior to 1950. Publications especially helpful in this endeavor were Jim Yoakum's (1967) annotated bibliography on the species, Morris Heller's (1997) bibliography of hunting books, and Eric Mellink's (2000) biography of collector Edward Funcke. The following bibliography, while comprehensive, is not exhaustive, and other sources, especially those in Spanish and referring to the Spanish period, remain to be uncovered.

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* Corresponding Author

[6] One in Inyo County, 8 in Kern County, 9 in Los Angeles County, 5 in Mono County, 2 in Riverside County, 3 in San Benito County, and 3 in San Bernardino County.

Results

In addition to the museum specimens shown in Table 1, we have assembled the following historic references to pronghorn in the Californias south of San Francisco Bay:

Anderson, H. T., Jr. 1932. The pronghorn antelope. California Fish and Game 18: 258–259.

Anderson reports on recent pronghorn sightings in the Mojave Desert near Randsburg and in Antelope Valley.

Anderson, H. T., Jr. 1934. The pronghorn antelope in Los Angeles County, California Fish and Game 20:91–92.

A total of seven pronghorn was reported in Los Angeles County in July, 1932. By December 1933 only four does could be located in the rolling low hills of Antelope Valley. With no males present it was apparent that the county's pronghorn would soon be extirpated.

Bolton, H. E. 1927. Fray Juan Crespi, Missionary Explorer on the Pacific Coast, 1769–1774. University of California Press, Berkeley.

While crossing the Salinas Valley on September 27, 1769, Father Crespi reported: "*We saw in this day's march two bands of antelope some distance from us,*" and the next day, near the present site of Greenfield (Gordon 1979), "*some bands of antelope were seen but not within gunshot.*"

Brewer, W. H. 1930. F. Farquhar, ed. Up and Down California in 1860–1864. University of California Press, Berkeley.

Near New Idria, east of Tres Pinos, San Benito Co., while in the valley of Little Panoche Creek, Brewer reported that, "*we came on a drove of ten antelope, the first we have seen. They were very plentiful a few years ago in this state, in large flocks.*" Earlier, on June 10, 1861, Brewer reports coming upon a herd of "*thirty or forty antelope*" at Canada del Puerto in Stanislaus County, and later, on June 19, he and his party saw a herd of pronghorn in the San Joaquin Valley near San Luis (Merced Co.) 27 miles from Pacheco Pass. Brewer goes on to report antelope in San Ramon Valley near Mount Diablo (Contra Costa Co.), Pacheco Valley (Santa Clara Co.), and between Visalia and the Kern River in Kern County.

Bryant, E. 1848. What I saw in California. D. Appleton and Co., New York.

Bryant reported seeing "*several large droves of antelope and deer,*" some 40 to 50 miles above the mouth of the San Joaquin River (probably near present day Tracy in San Joaquin County). He also reported that the San Joaquin Plain was furrowed with deep trails of horses, elk, deer, and antelope. Bryant considered antelope as occurring in California in "*large numbers*" with "*large flocks*" being present in the Sacramento Valley along the American River.

Burcham, L. T. 1957. California range land, an historico-ecological study of the range resources of California. California Department of Natural Resources, Sacramento. 261 p.

Prior to European settlement, the range lands of California were only used moderately by pronghorn, deer, and elk. Burcham provides several early accounts from journals referring to historic pronghorn distribution. "*Considered in its entirety, the native animal community had a relatively small effect on the plant cover.*" In parts of California, pronghorn were abundant and formed a mainstay of subsistence for the Indians, particularly in the San Joaquin Valley where the animals formed large herds numbering up to 2,000 to 3,000 head.

Caton, J. D. 1877. The antelope and deer of America. Forest and Stream Publishing Company, New York.

According to Dr. Canfield of Montera [Monterey], antelope were very abundant in the Monterey area's coastal grasslands from the Coast Ranges down to the sea 25 years earlier [early 1850's]. Canfield, who attempted to raise pronghorn in captivity, told Caton that "*California at this time* [ca. 1876] *is almost entirely deserted by them.*"

Cheney, E. S. 1929. California Fish and Game 15:175.

Cheney reports on the increasing numbers of pronghorn in California's northeastern counties but makes no mention of any animals in central or southern California.

Crosby, H. W. 2003. Gateway to Alta California: the expedition to San Diego, 1769. Sunbelt Publications, San Diego, CA.

This book quotes Fray Juan Crespi as stating that while riding west on April 14, 1769, along the Rio San Telmo in northern Baja California: "*there are many antelopes (we saw one group of nine of them together), and many coyotes and deer.*"

At San Diego, in May, 1769, Alferez Miguel Costanso, who had recently arrived by ship, remarks that, "*There are in the land, deer, antelope, many hares, rabbits, squirrels, wild cats, and rats.*"

Cudahy, J. 1928. Manañaland: adventuring with camera and rifle throughout California and Mexico. Duffield Publishing Co., New York.

Contains a lengthy account and several photographs of pronghorn hunting in Baja California, principally in the Tres Pozos and San Felipe areas. A most interesting book as it indicates that pronghorn remained locally common after being protected by Mexican law in 1922.

Dasmann, W. P. 1952. Antelope planting investigations. Calif. Dept. Fish and Game, Sacramento, CA. 6 p.

A report to the California Fish and Game Commission on possible pronghorn translocation sites in California, Dasmann considers few if any of the remaining rangelands in suitable condition for a transplant.

De Lewenhaupt, C. A. C. 1933. Sport across the world. Jarrold's London.

Contains a reminiscence of an earlier hunt out of La Paz, "*towards the plateau of Timales, after having crossed the rough slopes of San Pedro.*" Here, the author reports he and his partner killing a buck out of a little herd of antelope, which "*are now beginning to grow scarce.*"

Eisen, Gustav. 1895. Explorations in the Cape region of Baja California in 1894, with references to former expeditions of the California Academy of Sciences. Proc. Calif. Acad. Sci. 2nd Ser. V: 733–775.

Some of these expeditions undoubtedly reported the presence of pronghorn. Unfortunately, the fire of April 1906 destroyed all of these collections along with any museum records.

Elliot, D. G. 1903. A list of mammals collected by Edmund Heller in the San Pedro Martir and Hanson Laguna Mountains and the accompanying coast regions of Lower California with descriptions of apparent new species. Field Columb. Mus. Publ. 79, Zool. Ser. 3, No. 12:208.

A juvenile male pronghorn is taken near San Felipe, on the Gulf of California. The author also states that "*At rare intervals antelope have been observed at Rosarito*"; tracks were seen at San Matias Spring; and the animals "*occasionally come into the Cañon Esperanza for water from the near-lying desert.*" Writing in San Quintin, Heller writes that "*a few occurred until recently west of the bay on the north end of the peninsula west of the town. This was apparently their northern range on the Pacific coast. It is not rare on the coast south of this place.*"

Inland from the coast of San Felipe Bay, he wrote that "*a few antelope inhabit the plains near the bay, but from the number of tracks seen there are probably less than a dozen. No herds of any size occur and they are usually seen singly or in bunches of three or four. The Indians report seeing as many as fifteen occasionally in a band.*"

Elliot, D. G. 1904. Catalogue of mammals collected by E. Heller in southern California. Field Columbian Museum Publ. 91. Zool. Series. Vol. 3(16):284–285.

Two specimens, a male and a female, were collected in Antelope Valley near the eastern base of Tehachapi Mountains. On page 2 (Plate 41), there is a photograph of a captive female pronghorn near Fort Tejon.

Heller found a herd of 30 pronghorn in the western edge of the Mohave Desert near the eastern base of the Tehachapi Mountains in Kern County, California, the "*remnant of the hundreds that recently inhabited this arm of the desert.*" He describes the habitat as a heavy forest of "*tree-yuccas*" [Joshua trees]," which is flanked by an open adobe plain supporting a scanty growth of bunchgrass and afileria [filaree], including the bases of the bordering hills and mountains. These animals used to winter in small, sheltered valleys among the foothills where they fawned. He says the horns are shed in early October or late in September and the animals breed in mid-summer. A female taken in the middle of October contained two embryos about 3 months old. He also knew of a herd of 7 "*on the open plains*" of the San Joaquin side of Tehachapi Pass, with another 7 or so farther west near Buena Vista Lake in Kern County and another herd on the Carrizo Plains on the western side of the San Joaquin Valley. He also stated that this species was formerly thought to move freely between the Mohave Desert and the San Joaquin Valley.

Ely, A. (Chair). 1939. North American big game. Boone and Crockett Club and Charles Scribner's Sons, New York and London.

Contains a listing of the then highest scoring pronghorn trophies in the Boone and Crockett record book including a buck with 16" horns taken by E. W. Funcke in Lower California.

Freeman, Lewis R. 1904–05. A new sportsman's paradise. Western Field 5(1904): 191–197, 269–271, 352–360; 1905:445–451. Reprinted in the Pacific Monthly in March 1909 in "*The Mountain Sheep of North America.*"

Reports an abundance of antelope and bighorn on the west slopes of the Sierra Pinta in northeastern Baja California.

Fremont, John C. 1849. Notes of travel in California. D. Appleton and Co., New York. p. 36.

Fremont's impressions of the natural history of mid 19th Century California's are especially interesting in that they are usually accompanied by botanical descriptions of the forbs and grasses present including California poppy, wild pea, filaree, wild oats, etc. These include the following passage describing the countryside around Tulare Lake in early January in what is now Kern County: "We traveled among multitudinous herds of elk, antelope, and wild horses. Several of the latter, which we killed for food, were found to be very fat."

Funcke, E. W. 1915. The sheep hunting of Lower California. Outdoor Life. Sept. 221–228.

Discusses and maps the distribution of bighorn sheep, pronghorn and mule deer in northern Baja California.

Funcke, E. W. 1919. Hunting antelope for museum specimens. Field and Stream. March: 834–36.

Captain Funcke discusses his guiding and hunting expeditions for pronghorn in Baja California, often at the request of American museums. Funcke was an accomplished hunter and a relentless collector, securing more pronghorn specimens from the region than all other collectors combined.

Gordon, B. L. 1979. Monterey Bay Area: natural history and cultural imprints. 2nd ed. The Boxwood Press, Pacific Grove, CA.

Citing old newspaper articles, Gordon noted that in January 1852, "*We rode along the hills in the east and northeast side of the Salinas Plains* (west base of the northern Sierra Gabilon). . . *We saw several bear and plenty of deer and antelope* (*Salinas City Index, February 15, 1877*).

And, also in Monterey County: "*older settlers can remember the time in the Hildrethe and Dunphy herding days when antelope were not uncommon on the Salinas plains from Gonzales southward*" (*MontereyDemocrat, June 30, 1888: 6*).

Gordon also cited a 1770 entry near the present site of Chular by Fr. Pedro Fages 1911:149: "*many herds of antelope; some of them exceeding fifty.*"

Gordon also cites "*Life in California,*" 1947, (Biobooks, Oakland:69), in which A. Robinson state's that there were also antelope in the upper drainage of the Pajaro River in the Santa Clara Valley (Santa Cruz County).

Graves, J. A. 1912. Out of doors, California and Oregon. Grafton Publ. Co., Los Angeles, CA.

In 1876 Graves and an old hunter named Chavin kill two bucks out of a large herd of pronghorn near the Liebre Ranch on Rock Creek, not far from Elizabeth Lake in Los Angeles County. This site, near where Fairmont is located, was then a grassy *cienéga.*

Graves, J. A. 1927. My seventy years in California: 1857–1927. Times-Mirror Press, Los Angeles.

Contains a reminiscence of Graves and his partner killing "*two fine buck antelope*" in the fall of 1876 near Rock Creek in Los Angeles County at the western end of Antelope Valley not far from Rancho Liebre. The following year, Graves and about a dozen others drove a wagon from Los Angeles to Willow Springs, west of Mohave, where they waylaid a large band of pronghorn coming to water and killed 17. Another member of the party claimed the number was 27, the party dressing the pronghorn in the willow trees near the spring. Graves also reported seeing bands of antelope from the train when travelling through Antelope Valley.

Grinnell, J. 1933. Review of the recent mammal fauna of California. Univ. California Publ. in Zool.40:209.

Pronghorn "*occurred westwardly at north to Shasta valley, Siskiyou County; centrally to open hills of Contra Costa County and to Salinas Valley, Monterey County; and southerly, at least to piedmont or mesa region where Pasadena is now located and to San Jacinto Valley in Riverside County. Within recent years only isolated bands exist: largest of these [of several separate bands there] in Modoc region . . .; a small band on west side of San Joaquin Valley in western*

Fresno County [none definitely reported later than 1928]; *a very few western arm of Mohave Desert* [Antelope Valley] *in northern Los Angeles County or southern Kern County; a small herd in northwestern San Bernardino County near Randsburg; and a few individuals on west of Colorado Desert near the Mexican line, in eastern San Diego County or western Imperial County* [Nelson 1925]".

Guzmán, G., Jr. 1961. Vegetation zones of the territory of Baja California in relation to wildlife. Trans. Desert Bighorn Council 5:68–74.

Guzmán describes five major biotic zones for Baja California and states that pronghorn now only are found in one of these—the Vizcaíno Desert on the Pacific side of the middle of the peninsula.

Hall, E. R., and K. R. Kelson. 1959. The mammals of North America. Ronald Press, New York.

Shows distribution dots and marginal records for pronghorn in Antelope Valley, CA; west side of Colorado Desert near Mexican border in the vicinity of Campo, CA; San Jacinto Valley, CA; Salinas Valley, CA; and Contra Costa County, CA. Marginal records in Baja California are from Cañon Esperanza, San Felipe Bay, inland from Santa Rosalía Bay, south beyond Magdalena Bay, Vizcaíno Bay, and San Quintín.

Holder, C. F. 1906. Life in the open. Sport with rod, gun, horse and hound in southern California. G. Putnam's Sons, London and Knickerbacher Press, New York.

States that pronghorn in large bands can be found near Elizabeth Lake and in Antelope Valley. Yet, in a 1902 map of pronghorn distribution in California prepared by C. H. Merriam, this species is shown as occurring only in northeastern California and in Imperial Valley.

Huey, L. M. 1964. The mammals of Baja California, Mexico. Trans. San Diego Soc. Nat. Hist. 13:85–168.

The author reports having observed freshly killed pronghorn taken in 1908 and 1909 in El Valle de la Trinidad by a local big game hunter. This valley and other "high" valleys such as Valle de Rodeo west of the Sierra San Pedro Martír appear to have been good pronghorn habitat.

Huey reports this species as having been extirpated in northern BC and predicted that the pronghorn would be extinct in BCS within 20 years. At the time of his report, the species reputedly could still be found in the desert valleys north and south of Bahia de Los Angeles on the east coast and east of Scammon's Lagoon on the west coast of BCS.

Humboldt, A. von. 1811. Essai politique sur le Royaume de la Nouvelle Espagne. 2 vol. Paris, France.

Reports pronghorn near Monterey, CA.

Humphrey, W. E. 1911–12. Shooting the vanishing sheep of the desert. Outdoor Life 28, Dec. (6):477–487, 29, Jan. (1):3–16.

Humphrey and his wife hunt for bighorn and pronghorn in BC with E. W. Funcke in October and November 1909. He kills a buck pronghorn near Tres Pozos, BC, which was reportedly to be used in a desert display at the University of Washington [now the Burke Museum]. See Table 1.

Jaeger, E. C. 1956. Last stand of the pronghorn. Desert Mag. 19 (7):17–18.

References are provided for the last known pronghorn observations in California's Sonoran and Mojave deserts.

Jaeger, E. C. 1957. The North American deserts. Stanford University Press, Palo Alto, CA, p. 97.

States that a few pronghorn were known to roam the plains northeast of the Chocolate Mountains on the plains drained by tributaries of Arroyo Seco or Milpitas Wash prior to 1941 when this area was withdrawn for use by the U.S. Navy.

Jaeger, E. C. 1961. Desert wildlife. Stanford University Press, Palo Alto, CA. p. 56.

Repeats the accusation that the U.S. military was responsible for the extirpation of pronghorn in the Colorado and Mojave deserts of California during WWII.

Jones, F. L. 1954. Report on resurvey of proposed antelope planting sites. California Department of Fish and Game, Sacramento. 13 p.

A resurvey of the 16 potential translocation sites reported by Dasmann (1952) showed only two to be suitable due to insufficient forage and water. The report also stated that good release sites for desert pronghorn might also be available, but that there was insufficient knowledge of the forage and water requirements of "Sonoran" pronghorn.

Kent, W. 1929. Reminiscences of outdoor life. A. M. Robertson, San Francisco, CA.

This account is most valuable for its description of E. W. Funcke's background as a sea otter hunter off of the coast of BC prior to his marrying a Mexican woman and taking up big game guiding as a profession. Funcke guides Kent, accompanied by Stewart Edward White and Samuel H. Adams, into the desert ranges of northeastern BC where "*scattered*" bands of antelope are said to occur and where they kill 60 to 70 bighorn in a little over two weeks time.

Kidwell, Art. 1996. Bill McHaney: he found and lost a gold mine. Hi-Desert Mag. Summer: 11.

Anecdotal statement by McHaney that when he first arrived in a high valley within today's Joshua Tree National Park in 1879 that the "valley was full of antelope" and the area's lush grass was "belly-high on a horse."

Koch, A. J., and J. D. Yoakum. 2002. Reintroduction and status of pronghorn on the Carrizo Plain National Monument and surrounding areas in southern California. Proceedings of biennial pronghorn workshop 20:25–41.

Documents the introductions and status of pronghorn in the Carrizo Plain, Fort

Table 1. Pronghorn Antelope from Southern California and Baja California in Natural History Museum Collections.

Institution	Spec. #	Sex	dd/mm/year	Collector	Location	Notes
AMNH	77941	M	March, 1917	R. C. Murphy?	Tres Pozos, BC	Possibly 1 of 8 pronghorn collected in 1917 for Brooklyn Museum E. W. Funcke and party
ABDSP					Borrego Badlands, San Diego Co.	Partial jaw
ABDSP			10-May-1905		Split Mtn./Fish Creek, San Diego Co.	Skull cap and partial horn
CAS	4140	?	3-Aug-1922	G. D. Hanna & F. Tose	Punta Abreojos, BCS	
FMNH	13105	M	25-Mar-1902	Edmund Heller	San Felipe, BC	Skin and skull
FMNH	21756	M	16-Oct-1903	Edmund Heller	Neenach, Los Angeles Co. CA	Skin and skull
FMNH	21755	F	16-Oct-1903	Edmund Heller	Neenach, Los Angeles Co. CA	Skin and skull
MCZ	65	M	26-Mar-1905			Plus 4 other males and several females collected by E. W. Funcke near Calmalli, BCS
MVZ	31156	M	28-Mar-1920	Joseph S. Dixon	10 mi. w of Mendota, Fresno Co.	Fawn
MVZ	31157	F	28-Mar-1920	Joseph S. Dixon	10 mi. w of Mendota, Fresno Co.	Doe
MVZ	37932	?	10-Dec-1926	Ches. C. Lamb	Valle Trinidad, BC	
MVZ	50239	M	19-Jul-1931	Ches. C. Lamb	Chapala, BC	
MVZ	50240	?	8-Mar-1931	Ches. C. Lamb	Chapala, BC	
MVZ	19175	M	22-Aug-1912	E. W. Funcke	60 mi. s of Calmalli, BCS	300′ elev.
MVZ	19176	F	19-Aug-1912	E. W. Funcke	60 mi. s of Calmalli, BCS	
UNAM	3874	?	April, 1984	Villa-R., B.	Cruce de Letreros, Vizcaino desert	
USNM	203132	M	16-Jan-1914	E. W. Funcke	5 mi. s Caparote, BC	
USNM	203133	M	16-Jan-1914	E. W. Funcke	5 mi. s Caparote, BC	
USNM	203143	M	8-Jan-1914	E. W. Funcke	8 mi. s Tres Pozos, BC	
USNM	203144	F	8-Jan-1914	E. W. Funcke	8 mi. s Tres Pozos, BC	
USNM	203145	F	16-Jan-1914	E. W. Funcke	7 mi. n Tres Pozos, BC	
USNM	203179	M	24-Feb-1914	E. W. Funcke	6 mi. n Tres Pozos, BC	
USNM	178392	M	13-Sep-1911	E. W. Funcke	2.5 mi. w Calmalli, BCS	
USNM	178393	F	1-Sep-1911	E. W. Funcke	2.5 mi. w Calmalli, BCS	
USNM	178394	F	1-Sep-1911	E. W. Funcke	2.5 mi. w Calmalli, BCS	
USNM	178395	M	1-Dec-1911	E. W. Funcke	ca. Calmalli, BCS	
USNM	178443	M	16-Mar-1916	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	178444	F	2-Dec-1911	E. W. Funcke	ca. Calmalli, BCS	

Table 1. Continued.

Institution	Spec. #	Sex	dd/mm/year	Collector	Location	Notes
USNM	178445	M	4-Feb-1912	E. W. Funcke	45 mi. s Calmalli, BCS	
USNM	178446	M	5-Feb-1912	E. W. Funcke	ca. Calmalli, BCS	
USNM	178447	F	5-Feb-1912	E. W. Funcke	ca. Calmalli, BCS	
USNM	178448	M	15-Feb-1912	E. W. Funcke	ca. Calmalli, BCS	
USNM	178449	M	16-Feb-1912	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	178450	F	16-Feb-1912	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	178451	M	18-Feb-1912	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	179665	M	4-May-1912	E. W. Funcke	45 mi. w Calmalli, BCS	
USNM	179666	M	18-May-1912	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	179667	F	8-Jun-1912	E. W. Funcke	45 mi. s Calmalli, BCS	
USNM	179668	M	8-Jun-1912	E. W. Funcke	45 mi. s Calmalli, BCS	
USNM	179669	M	3-Jun-1912	E. W. Funcke	45 mi. s Calmalli, BCS	
USNM	179670	M	20-May-1912	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	179671	M	19-May-1912	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	179672	M	4-May-1912	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	179673	F	20-May-1912	E. W. Funcke	50 mi. s Calmalli, BCS	
USNM	179674	F	16-Feb-1912	E. W. Funcke	30 mi. s Calmalli, BCS	
USNM	A0003	M		J. Xantus	Ca. Fort Tejon, CA	Skull only
USNM	534	M	Nov, 1911	D. J. Singer	Calexico, CA	Skull only; from Tres Pozos?
UWBM	218001	M	23-Mar-1905	W. E. Humphrey	Tres Pozos, BC	

Abbreviations: AMNH = American Museum of Natural History; BMNH = British Museum of Natural History; CAS = California Academy of Sciences; USNM = National Musem of Natural History; MVZ = Museum of Vertebrate Zoology, UC Berkeley; MCZ = Museum of Comparative Zoology, Harvard; FMNH = Field Museum of Natural History, Chicago; UWBM = Burke Museum, Univ. of Washington; UNAM = Universidad Autonoma de Mexico, Mexico City; ABDSP = Anza-Borrego Desert State Park, Borrego Springs, CA; BC = Baja California; BCS = Baja California Sur.

Tejon Ranch, Cholame Valley and other southern California locations as a result of transplants from northeastern California between 1985 and 1990.

Larsen, H. (Mrs.) 1929. The antelope near Fresno. California Fish and Game 15(4): 350–351.

Mrs. Larsen describes how she came to Fresno County in 1878 as a homesteader and how in 1879 bands of 40–50 antelope were feeding on the settler's new alfalfa crops. The pronghorn diminished with settlement although she and her son later saw herds near Firebaugh and in the more open reaches of the Coast Range. One of the last herds was a population of about 50 near the mouth of Salt Creek near Panoche Pass in the "*Joaquin Murrieta country.*"

Leopold, A. S. 1959. Wildlife of Mexico: the game birds and mammals. University of California Press, Berkeley, Los Angeles and London.

Leopold reported that a S. B. Benson found scattered bands of pronghorn in northwestern Sonora and in northeastern Baja California near San Felipe on various trips between 1936 and 1948. He also stated that Raymond Gilmore had been told in July 1956 that bands of up to 30 pronghorn were often see on the Vizcaíno plain east of Black Warrior Lagoon in July, 1956 and that hunters still pursued them.

McLean, D. D. 1944. The prong-horned antelope in California. California Fish and Game 30:221–239.

Although focusing on the Modoc Plateau in northeast California, McLean maps the historical occurrence of pronghorn in California as all of the plains, valleys and deserts including the valleys west of the Coast Ranges to as far north as Sonoma County.

Mearns, E. A. 1907. Mammals of the Mexican Boundary Survey of the United States. U.S. National Mus. Bull. 56, Part I. Washington, D.C.

Mearns states that some antelope, though not abundant, remained on the Colorado Desert in both Californias. He saw their tracks near Gardner's and Laguna stations along the border, and records having seen a specimen taken by A. W. Anthony; west of the Coast Range in Lower California.

Meyers, L. H. 1963. A general history of the pronghorn antelope in California. Intern. Antelope Conference Trans. 14:81–102.

Meyers provides a literature review of California pronghorn with some 60 references being listed.

Monson, G. 1968. The desert pronghorn. Trans. Desert Bighorn Council 12:63–69.

Monson discusses the former distributions of the "Sonoran" and "Peninsular" pronghorn and proposes that they be referred to as "desert pronghorn."

Murphy, Robert Cushman. 1917. The desert life group, and an account of the museum expedition into Lower California. Brooklyn Museum Quarterly V (=IV), No. 4:179–210.

Murphy, Robert Cushman. 1917. Natural history observations from the Mexican portion of the Colorado Desert with a note on the Lower Californian pronghorn and a list of the birds. Proc. Linnean Soc. New York 29:43–101.

In the above accounts, Murphy, accompanied by Robert Rodwell (chief taxidermist) and Edward W. Funcke of San Ysidro, CA, embark on a pronghorn expedition to Tres Pozos and the Pattie Basin of BC in 1915. On April 7 he reported that the "*heart-shaped tracks of antelopes were visible everywhere, but were mostly old.*" Later that day he saw a lone buck and then a herd of 7 or 8 in the Pattie Basin just north of San Felipe, none of which was secured. Nine more pronghorn were seen on April 3, and on April 4 a fawn was killed 7 miles from Tres Pozos. Two more "*half-grown*" pronghorn were killed toward Caparote by Funcke on April 7. On his return, the party frightened a small band in a pass cutting through the Tinajas Mountains on April 11.

He returned with Mrs. Murphy on April 23 during which time more pronghorn were observed and at least 1 killed, none of which are presently in the Brooklyn Museum of Art and Culture. Murphy considered the pronghorn in Pattie Basin much reduced in numbers as he only saw 50-60 animals, mostly in singles, in 11 days. All were extremely wild. Based on the size of the fawns observed and collected, he and Funcke estimated the birthing time to be in late February. Major spring foods were desert broom-rape and trailing four-o-clock, with ironwood taken at other times.

Later, between March 16 and 25, 1917, Funcke sent 8 pronghorn from the Tres Pozos area to the Brooklyn Museum.

Nelson, E. W. 1912. A new subspecies of pronghorn antelope from Lower California. Proc. Biol. Soc. Washington 25:107–108.

Nelson describes the type specimen of *Antilocapra americana peninsularis* taken near Calmalli by E. W. Funcke.

Nelson, E. W. 1922 (1966). Lower California and its natural resources. National Acad. Sci. 61:1–194. 1st Memoir.

"*Antelopes, once so numerous on the open plains of the peninsula, have become exterminated over considerable areas. None appear to be left in the northwestern part of the peninsula west of the mountains, and north of El Rosario. They are also gone from the great Magdalena Plain* [south of where Nelson: 64 said they once occurred]. *Small numbers still exist on the desert south of the Cocopah Mountains and back of San Felipe Bay, as well as in various other localities, thence south to the Vizcaíno Desert, where they are still more numerous than elsewhere. It is evident, however, that these animals are fated to disappear from this region in the not distant future.*"

Nelson, E. W. 1925. Status of the pronghorned antelope, 1922–1924. USDA Bull. 1346:1–64.

In his statewide compilation, Nelson reported a census of 1070 pronghorn in California. Most of these animals (980) were in the northeastern part of the state, but a herd of about 30 was also reported as being present in 1922 between Granite Wells and Randsburg in the Mohave Desert, with another band of 11 in Antelope Valley along the Kern-Los Angeles County line. He also reported, but did not map, a band of 13 as having been seen in 1924 between Willow Springs and Liebre Ranch on the west side of Antelope Valley in Kern County. Two bands totaling 29 head were also reported from the San Joaquin Valley between Mendota and Panache Creeks in Fresno County. Another small band of 5 animals was also reported as occurring in 1922 on the "*Colorado Desert*" along the Imperial–San Diego County border near Campo.

Nelson's informants estimated about 200 pronghorn on the east side of BC from the California border to the boundary of what is now BCS. Another 100 to 300 animals were thought to be in the Vizcaíno Desert in BCS between Vizcaíno and Ballenas bays.

Newberry, J. S., M.D. 1855. Report upon the zoology of the route. No. 2, Chap. 1, pp. 70–71 *In* H. L. Abbot. 1857. Reports of explorations and surveys to ascertain. . . etc. U.S. Senate ex. Doc. No 78, Vol. 7, Washington D.C.

Page 71: "*Though found in nearly all parts of the territory of the United States west of the Mississippi, it* [Antilocapra Americana] *is probably most numerous in the valley of the San Joaquin, California. There it is found in herds literally of thousands; and though it is much reduced in numbers by the war which is incessantly and remorselessly waged upon it, it is still so common that its flesh is cheaper and more abundant in the markets of the Californian cities than that of any other animal. On nearly every day's march between the valley of the Sacramento and the Columbia, we saw either the antelope itself or its peculiar track in the sand.*"

"*In the Sacramento Valley they have become rare, and the few still remaining are excessively wild.*"

North, A. W. 1907. Hunting the bighorn. Sunset Magazine. Oct.:523–532.

North, A. W. 1910. Camp and camino in Lower California. Baker and Taylor Co. New York.

North was in Baja California from December 1905 until May 1906, and then again, from July through September 1906. He hunted both bighorn and pronghorn in what is now BC and BCS.

P. 106: "*South of Youbai we crossed the tapering of two level valleys extending down towards the Gulf and containing several thousand acres with grass and brush. According to Otero a few antelope ranged in this section. . . Like the Llanos de Buenos Ayres and the Llanos de Santa Maria, which are also inhabited by small bands of antelope—this region is barren of springs.*"

P. 144: "*Presently, leaving the rolling hills behind, we entered upon the Llanos de Ojo Liebre, or Plains of a Hare's Eye, sometimes also called Antelope Plains, an immense barren, expanse, bordered by the San Pablo Sierras on the east, the Santa Clara Sierras on the south and a low horizon on the west. With its numerous curving swales and rounded sand hills, the vast field covered with waving grasses, bobbing wild flowers and small, fretful leguminous plants, spread out before us like some billowy sea.*

Soon I saw my first prong-horn or antelope. . .

Early in the afternoon we came upon three antelope, though I, personally, saw *only one, a fine prong-horn buck.*" North goes on to describe killing his first pronghorn, a buck, near the Calmalli-San Ignacio road while en route to San Angel. Four days later they arrive at San Ignacio having crossed the peninsula from Pozo de Ojo Liebre.

North, Oliver (Mullen, W.) 1876. Rambles after Sport or Travels and adventures in the Americas and at home. The Field Office, London.

An Englishman's account of hunting in the Californias in the 1860s. He reports pronghorn as then being fairly common in the Ensenada area.

O'Gara, B. W., and J. D. Yoakum. 2004. Pronghorn: ecology and management. Wildlife Management Institute and Univ. Colorado Press.

On page 547 there is a photo, *ca.* 1920, of one of the last pronghorn killed in the San Joaquin Valley. Restoration attempts in the Carrizo Plains and other California locales are also summarized.

Paez, J. 1542–1543. Cabrillo's Log. trans. J. R. Moriarty and M. Keistman. The Western Explorer, vol V, no. 2 and 3, Cabrillo Historical Association. San Diego, CA, September 1968.

In September 1542, Cabrillo reported seeing "*herds of animals like domestic animals which were in the number of a hundred or more*" on the grassy savannas at Ensenada, Baja California. His further descriptions of the animals could only refer to pronghorn.

Phillips, J. C. 1913. The Lower California pronghorn antelope. Science, May 9: 717–718.

Phillips describes the Museum of Comparative Zoology's (Harvard) recent acquisition of 5 male and several female pronghorn collected by E. W. Funcke in the Calmalli area of BCS. He notes that one of the males, #65 in the MCZ collection, has horns 16¼ × 6¼" long and is the 5th largest specimen in the 6th edition of Rowland Ward's record book.

Priestly, H. I. 1937. A historical, political, and natural description of California by Pedro Fages, soldier of Spain. Univ. of California Press, Berkeley. 83 pp.

In 1769, while Fages was traveling with the Portola expedition through the San Diego area, he reports observing "*deer, antelope, conies, hares without number, wildcats, wolves, some bears, coyotes and squirrels of three kinds.*"

Singer, Dan. J. 1916?. Desert trails. Field and Stream. Sept. 413–416, Oct. 503–506, Nov. 588–590, Dec. 678–681.

Not seen. This article may describe a hunt with E. W. Funcke and the collecting of Singer's pronghorn in the U.S. National Museum (Table 1).

Slade, C. B. 1902. Hunting sheep and antelope in Lower California. Outing 39 (Feb):505–512.

Slade kills a buck pronghorn out of a group of 3 on Mesa Huatamote (due east of El Rosario) between the "*Stone Corral*" near San Juan de Dios (Espinosa's Ranch) and La Tinaja. The antelope was near a dead juniper and on a high mesa 25 miles north of the "Plains of San Agustine" (Llanos San Agustin) 20 miles from the coast. His party had left from San Quintín.

Stephens, F. 1906. California mammals. West Coast Publishing Co., San Diego, CA.

"In 1877 I saw a band of about 2 dozen where Perris, Riverside County, now stands, and the next year I saw one within the limits of what is now the city of Riverside. At this writing they are almost exterminated in this State. There are a very few in Modoc, Lassen and Mono Counties, and a small band or two in the deserts in the southeastern part of the State. All told there may be two or three hundred left and this number is steadily diminishing."

Stephens, F. 1921. An annotated list of the mammals of San Diego County, California. Trans. San Diego Soc. Nat. History 3:41–56.

Stephens reports the presence of four pronghorn at Carrizo Creek in the Anza Borrego Desert "many years ago."

Tinker, B. 1978. Mexican Wilderness and Wildlife. Univ. Texas Press: Austin, TX.

Tinker, who collected several pronghorn in Sonora and Baja California, provides a description and account of an animal bagged in BC, giving its weight and measurements. Tinker's reports are unreliable, however.

Townsend, C. H. 1912. Mammals collected by the Albatross Expedition in Lower California in 1911, with descriptions of new species. Bull. Amer. Mus. Nat. Hist. 31:119.

Townsend collects a pronghorn inland from San Felipe for the Field Museum in Chicago.

Van Dyke, T. S. 1888. The city and county of San Diego. The Pacific Press, Oakland and San Francisco.

Van Dyke, T. S. 1905. Sport on the Lower Colorado. Western Field 6:3–7.

Van Dyke reports pronghorn in El Cajon and Otay Mesa in San Diego County, the last one being killed in 1883.

Van Norden, O. H. 1919. Hunting in Laguna Salada. Outing 74:209–213, 260, 280–284, 316–317, 349–353, 380, 386.

More pronghorn hunting accounts in northeastern BC with the indomitable Captain Funcke.

Zwinger, A. 1986. John Xántus: the Fort Tejon letters, 1857–1859. University of Arizona Press, Tucson.

Xantus, while stationed at Fort Tejon in Kern County, California, reported seeing large herds of pronghorn from Tejon Peak in October 1857. A skull at the U.S. National Museum is attributed to him.

Discussion

The published accounts and associated specimens provide a fairly complete picture of pronghorn distribution in the Californias. The central valley of California was a population center prior to the valley being settled by farmers and the pronghorn undergoing pervasive and sustained hunting pressure. Pronghorn in both Californias ranged all the way to the coast at Monterey in the north southward to at least Magdalena Bay in Baja California Sur. Pronghorn also appear to have been fairly regularly distributed along mesas and valleys from coastal southern California, including the Riverside–Perris plain in western Riverside County and the coastal mesas in San Diego County. Along the Lower California peninsula, pronghorn ranged southward along both coasts to below San Felipe on the Gulf of California, and on the Pacific coast to at least Bahia San Ignacio, with records from Ensenada, San Telmo, San Quintin and El Rosario, as well as such high mountain valleys as near Campo (just north of the border) and Valle Trinidad. In the central portion of the peninsula there are specimens from Laguna Chapala in the Valle de los Cirios, with a large series collected about 50 miles south of Calmalli, southwest of the modern town of Vizcaíno. This is the site containing most of the remaining pronghorn population today. East of the Coast Ranges, pronghorn appear to have been abundant in the western Mojave desert and adjacent foothills, with lesser numbers found in the rest of desert southern California with the eastern base of the peninsular ranges in Baja California being a regular hunting locale in the early part of the 20th century. Here, undoubtedly due to its later settlement, the San Felipe desert sustained a large pronghorn population even after the species disappeared from most other Sonoran Desert locales in the U.S. The southern extent of the species range appeared to be in the Magdalena plain, although actual records there are vague, and any population in southern BCS must have been small.

Literature Cited

Heller, M. 1997. American hunting and fishing books: an annotated bibliography of books and booklets in American hunting and fishing 1800–1970. Nimrod and Piscator Press, Mesilla, New Mexico.

Koch, A. J., and J. D. Yoakum. 2002. Reintroduction and status of pronghorn on the Carrizo Plain National Monument and surrounding areas in southern California. Proceedings of the Biennial Pronghorn Workshop 20:25–41.

Mellink, E. 2000. Captain Edward William Funcke: hunting in Baja California for a living. J. San Diego History 46(1): 34–51.

Minnich, R.A., and R.J. Dezzani. 1998. Historical decline of coastal sage scrub in the Riverside–Perris plain, California. Western Birds 29(4): 366–391.

Weislander, A. E. 1934. Vegetation types of California, San Jacinto Quadrangle (1:125,000). U.S. Forest Service (published map).

Yoakum, J. 1967. Literature of the American pronghorn antelope: an annotated bibliography with abstracts emphasizing food habits and range relationships. U.S. Department of the Interior, Bureau of Land Management, Reno, NV.

Accepted for publication 10 June, 2005.

Bull. Southern California Acad. Sci.
105(1), 2006, pp. 17–29

Observations on the Mating Behavior of Captive Spotted Sand Bass (*Paralabrax maculatofasciatus*)

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Abstract.—The sex allocation pattern of various populations of spotted sand bass are thought to vary from functional gonochorism to strict protogyny. The development of hypotheses explaining how such a plastic (flexible) strategy has been maintained selectively has been hindered by a general lack of information on reproductive behavior in this species. Therefore, the spawning behavior of adult, wild-caught spotted sand bass were observed in captivity under a variety of densities. Three distinct spawning modes were observed: 1) pair spawning, 2) group spawning, and 3) spawning including a sneaker male. Courtship was characterized by the following sequence: 1) a male or males approach the females, 2) one or more males make contact with the ventro-lateral surface of the female and chase the female, 3) the male contacts the ventro-lateral surface of the female and pushes her through a vertical spawning rush. Spawning behavior involved ephemeral color changes, persistent physical contact initiated by the male, short rushes beginning near structure and ending in a vertical rush with a gamete release.

In general, in low density groups, reproductive activity was dominated by a single male that actively excluded smaller males from spawning. The dominant male in these groups exclusively engaged in pair spawning. Individuals in groups of higher density spawned in groups, with no observations of large males monopolizing females.

These observations are consistent with the predictions of the size-advantage hypothesis regarding mating strategies in fishes. We propose that these three spawning modes and the frequency with which they occur allow the flexibility seen in the mating strategies of isolated populations of spotted sand bass.

Introduction

The spotted sand bass, *Paralabrax maculatofasciatus,* is a shallow water serranid that inhabits the bays and lagoons of southern California, Baja California and the Gulf of California. These physically protected areas consist of eelgrass, surfgrass, rock/sand interfaces and serve as warm water refuges for this subtropical species (Allen 1985).

Spotted sand bass spawn in the summer (Allen et al. 1995) and are believed to be multiple spawners (Quast 1968). Oda et al. (1993) suggested that *Paralabrax maculatofasciatus* are capable of spawning on a daily basis. This species forms spawning aggregations at the entrances of bays in southern California, the pelagic eggs enter the plankton in coastal waters (Allen et al. 1995), and the juveniles settle out of the water column at 25 to 31 days (Allen, unpubl. data) off southern California.

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The spotted sand bass is the only known hermaphrodite among serranids common to southern California (Hastings 1989). However, the sex allocation pattern of various populations of spotted sand bass appear to vary from functional gonochorism to strict protogyny (Hovey and Allen 2000; Hovey et al. 2002). Hastings (1989) found three transitional individuals of this species collected from the northern Gulf of California and confirmed protogyny in that population. Following exhaustive sampling of six sites in California and along both sides of the Baja California Peninsula, Hovey and Allen (2000) also confirmed protogyny in fish sampled from San Diego Bay and Los Pulpos, Baja California (northern Gulf of California). They found five transitional individuals from these two sites. However, fish sampled from both Anaheim and Newport bays in southern California were considered as functionally gonochoric because they lacked transitional individuals and standard demographic patterns, although secondary males were collected at each site (Hovey and Allen 2000). In all populations of spotted sand bass examined, both primary and secondary males were present in all size classes.

Based on these studies, Hovey and Allen (2000) proposed that the size advantage hypothesis (Ghiselin 1969) could explain the reproductive patterns observed for each individual population of spotted sand bass examined. Low density spawning aggregations covering large areas may select for protogynous strategies in populations within San Diego Bay and the northern Gulf of California (Hovey and Allen 2000) because terminal males can dominate spawning activities (Allen et al. 1995). Functionally gonochoric populations, such as those in Anaheim Bay and Newport Bay appear to form dense groups in spatially restricted spawning areas, thereby allowing subordinate males to engage in spawning activities (Hovey and Allen 2000). The hypotheses regarding the impact of low and high density breeding aggregations on reproductive strategy in spotted sand bass have yet to be tested. In fact, prior to the current investigation, basic courtship and spawning behavior had not been described in this species, largely due to the high turbidity of the water in most spawning areas within embayments. Our initial prediction was that the plasticity of mating strategy (gonochorism to protogyny) described in different populations of this sea bass may be maintained by a variety of spawning strategies as seen in several species of wrasses (Warner and Hoffman 1980; Warner 1982 1984, Adreani and Allen, in press).

This paper describes our initial observations on the reproductive behavior of spotted sand bass in captivity. The specific objectives are to: 1) describe courtship and spawning behaviors of adult spotted sand bass and 2) to make preliminary observations on the effects of group size on the mating strategy of this protogynous hermaphrodite.

Materials and Methods

Observation Tank Design

Two types of tanks were used for behavioral observations. The first design used two (T1 and T2) circular 1,100 L indoor, insulated fiberglass tanks set up on a flow through system at the Science, Education, and Adventure Laboratory (SEA

Lab) located on the waterfront of King Harbor, Redondo Beach, California (33° 50.50′N, 118° 23.70′W). Both tanks were illuminated with 120 w plant lights set on timers to regulate the daylight cycle at 14 L:10 D to simulate mid-summer light cycles. Water in each tank was heated with 300-w submersible heaters suspended from two 2″ PVC pipes spanning the top of each tank. Each tank was stocked with wild-caught adults from San Diego Bay, California (32° 37.30′N, 117° 14.80′W) collected by hook and line in January 2002.

The second type of observation tank (T3) was a large (11,300 L) mobile aquarium that is equipped with a re-circulating two-stage (chemical and mechanical) filter system. This tank was housed at the Southern California Marine Institute (SCMI) on Terminal Island, in the Port of Los Angeles, California (33° 42.00′N, 118° 12.10′W) and was under natural light conditions. The walls of this tank (T3) are made of 3.8 cm thick transparent acrylic panels permitting a nearly unobstructed view of the fish. Water temperature ranged between 19 and 25 °C during observations. All of the spotted sand bass stocked in T3 were collected from Mission Bay, California (32° 45.54′N, 117°15.38′W) by hook and line in April 2003.

Tank T1 and T2 were stocked at one of two group densities. The T1 group consisted of 26 adults (20 fish/kl), with a minimum of five males (maximum 8 possible), to represent a high-density aggregation. The T2 group included ten adults (9 fish/kl), with three males, to represent a low-density aggregation. The group in T3 was adjusted to simulate several aggregation densities. The first group included eight adults (five females and three males; 0.7 fish/kl) and was observed for 10 nonconsecutive days over a 20 day period. Next, the group was reduced by three fish leaving two males and three females; then observed for eight nonconsecutive days over a 14 day period. Subsequent to the five-fish group (0.4 fish/kl), the group size was increased to 12 individuals (1 fish/kl) by the addition of seven adults (four females and three males). The final group of 12 fish was observed for seven nonconsecutive days over a period of 10 days.

Observation of Spawning

Observations of spawning behavior were made between 1700–2100 hr in tanks T1 and T2 from June to August 2002 and May to June 2003. Observations were made in T3 from August to October 2003. Behavior was observed in the tanks and videotaped with a Canon® digital video camera (Model ZR 45-MC) from a dorso-lateral angle. Various behaviors were catalogued by time of day, frequency, and number of fish involved, as well as the sex of those individuals when possible. Videos were later scored for the type of behavior, duration of interaction, coloration of involved individuals, relative position of individuals in relation to one another, and culmination of event (spawn, aborted rush or end of an agonistic interaction). Discrete, quantifiable acts of behavior were considered to be "bouts". Behaviors were generally categorized as aggressive, courting, and spawning (pair or group).

Aggressive behavior was defined as one or more fish exhibiting at least one of the following postures: flaring of fins, face off between individuals, high intensity color contrast flash, chasing, jaw snapping, and biting (Erisman and Allen 2005b). Courting behaviors were identified as intense male attention to a female including lateral display, slow following, physical contact by male on the ventro-lateral surface of female near the abdomen, and rapid movements over the top of the female. Spawning bouts involved a minimum of one male chasing one female in a vertical rush resulting in gamete release (Erisman and Allen 2005b).

Timing and detailed descriptions of courtship and spawning behaviors were recorded from T3 observations because of the increased visibility of these behaviors in comparison to T1 and T2. Pair-spawning events were characterized as only involving two individual fishes, one male and one female. Group spawning events involved three (>2 males and 1 female) or more individuals. Sneak/streak spawning events were therefore included in the group spawning category. Males and females were initially distinguished by sexual dichromatism as described in Allen et al. (1995). Sexual identity was later confirmed by activity and coloration during spawning.

Results

Spawning Modes and Courtship Behavior

During pre-courtship activities, females were dark-bodied, with black bars over a dark green background (Figure 1). During actual courtship and spawning periods, females developed a higher contrast color pattern with the background lightening to light green/off-white. Males exhibited a high-contrast pattern, black bars over a white background during the entire daily spawning period.

Spawning events were defined as interactions starting with a male initiating courtship by contacting a gravid female on her ventro-lateral surface and culminating in a spawning rush. Three distinct spawning modes were observed: 1) pair spawning, 2) group spawning, and 3) spawning including a sneaker male. Courtship involved one male and one gravid female in 10 of 18 spawning observations. On two occasions, two males were observed courting a female, but courtship followed the same pattern as with one male. No detailed courtship observations were made for the remaining spawning events (6/18) because of insufficient light and/or poor visibility, which prevented video-taping.

In pair spawning events, a courting male initiated contact with a gravid female by approaching from the side (Figure 2A). The female usually responded by swimming away slowly. The male then followed, mirroring the female's movements from behind and underneath (Figure 2B). The male usually moved from one side of the female to the other as he followed. Once the female stopped, she would begin to sink slowly. The male then followed her down, with his snout near her abdomen. Males often made contact with the abdomen of the female during this slow descent. The descent usually stopped about 1 m above the bottom of the tank. The female then raised her head to position her body at a 45° angle to the bottom and changed her color to a high contrast (black bar over a white background) pattern, similar to that of the male. The male then moved beneath the female and began a head-to-tail spiral chase, parallel to the bottom, gradually rising in the water column (Figure 2C). Chase sequences varied in length and speed. Males frequently ceased the chase momentarily, would swim away and then quickly return (Figure 2D). Males made frequent passes over or under the female (Figure 2E). Chasing behavior was common during courtship. During these bouts the male would often make contact with the female and initiate another short chase sequence. In the course of a chase the male often moved up to a

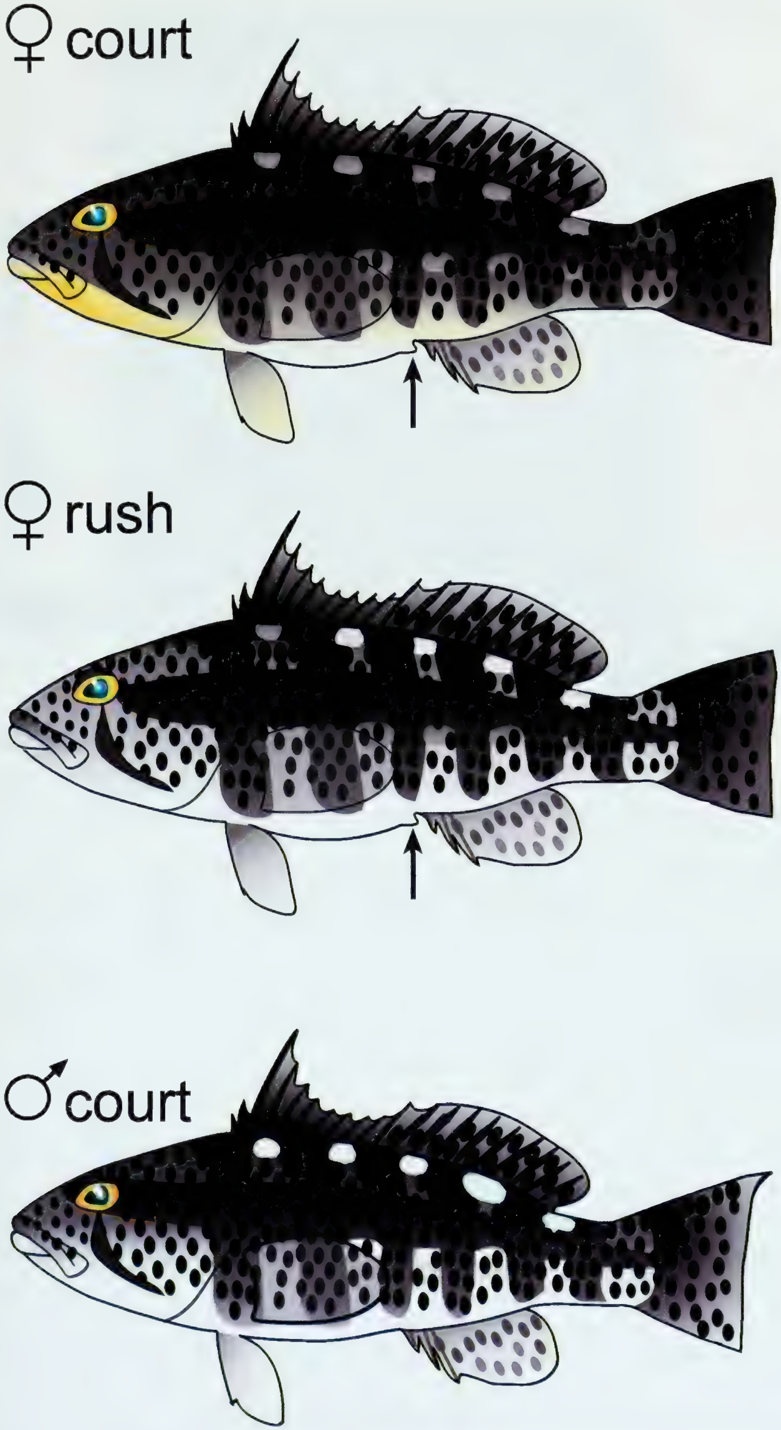

♀ court
♀ rush
♂ court

Fig. 1. Courtship-related coloration patterns in *Paralabrax maculatofasciatus*.

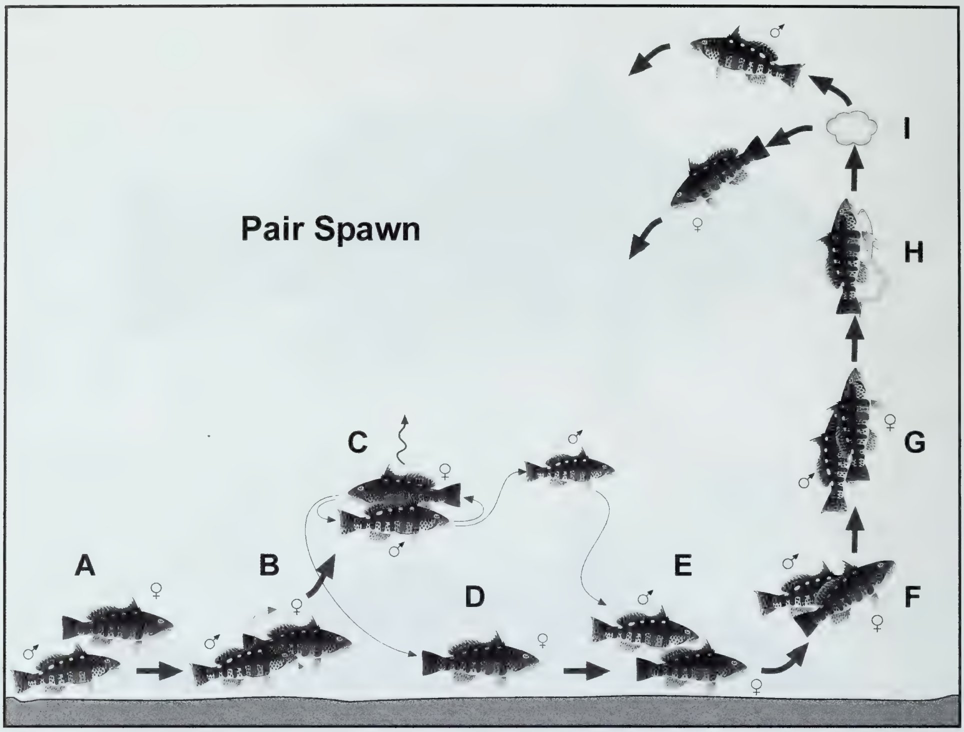


Fig. 2. Diagrammatic representation of *Paralabrax maculatofasciatus* pair spawn from courtship to gamete release. A. Initial contact of gravid female with dark contrast and a yellow chin by a high contrast male. B. Male contacts female abdomen. C. Flat spiral caused by male chasing female. Chase gradually moves vertically in water column. D. Male breaks off chase and leaves area. Female does not move far from position male left her. Male leaves for a short time, then returns quickly. E. The sequence may be repeated several times during a single courtship. F. Spawning pair initiates turn upward to begin spawning rush. Both male and female maintain courtship coloration. G. Spawning rush with both fish take on high contrast pattern. Male takes position with snout pushing at female near insertion point of second dorsal fin. H. Gamete release at near peak of rush. I. Rush peak, gamete cloud present with spawning pair separating. Female regains dark contrast with yellow chin color pattern and returns to structure, while male returns to bottom in search of another gravid female.

position near the origin of her second dorsal fin, and began pushing the female (Figure 3). Once in this position, the male directed the female upwards, initiating a rush to the surface (Figure 2F, G) and subsequent gamete release by both the female and male (Figure 2H). After the gamete release, the fish separated and returned to the bottom (Figure 2I). The females usually returned to shelter, and males began approaching other females, still exhibiting courtship coloration. Males tended to lose their courtship coloration after all females had been approached.

In a typical group spawn, courting males initiated contact with gravid females by approaching from the side (Figure 4). The female responded by swimming away slowly. The group of males converged on the female from all sides initiating a rush to the surface by all fish in the group. After the subsequent gamete release, all fish separated and returned to the bottom.

In a group spawn involving a sneaker male (Figure 5), courtship begins as in

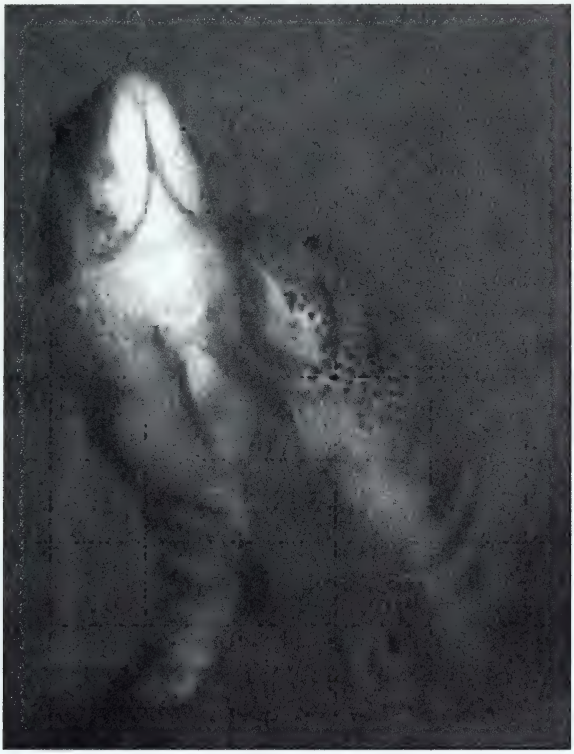


Fig. 3. A male *Paralabrax maculatofasciatus* in the position near the mid-dorsal region of a gravid female just prior to a vertical spawning rush to the surface.

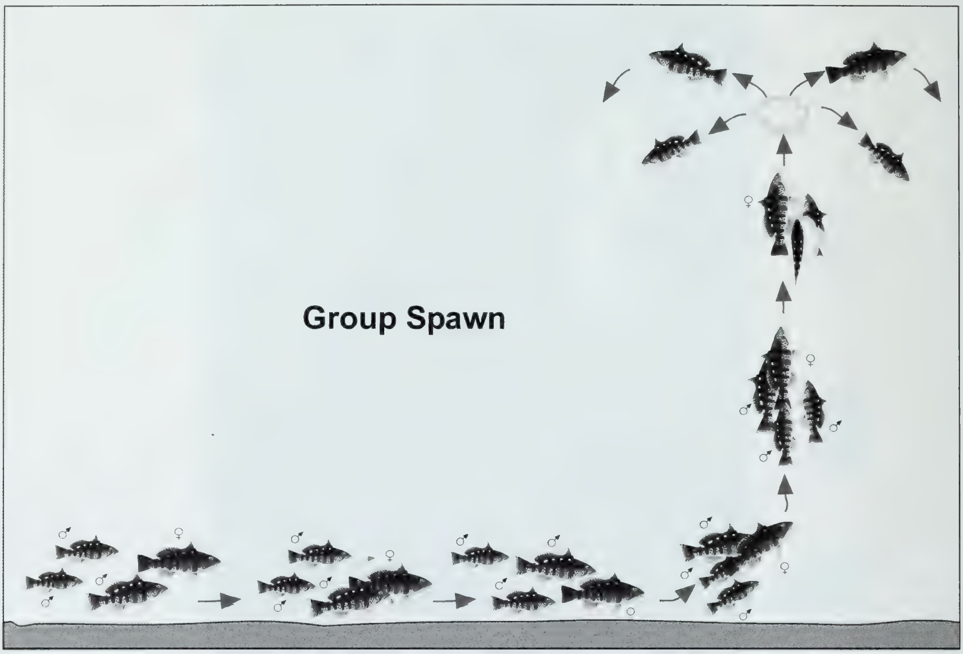
a pair spawn and is later interrupted by a male (sneaker) that joins as the original pair make their vertical turn to begin the spawning rush towards the surface. The sneaker, therefore, joined in the spawning rush and in subsequent gamete release. In one observation of a sneak spawn, the sneaker was observed colliding with and displacing the original courting male in close proximity to the female.

Spawning Times and Coloration

The mean duration of all spawning bouts was 127 seconds (range 45.1–190.1 sec). The mean spawning rush for the captive adults lasted 4 sec, measured from the vertical turn (that terminated courtship) to gamete release.

Spawning was observed from 1745–1945 hr in T3 (Figure 6). Most spawns (83%) occurred after 1900 hr, however, two spawns occurred at 1850 and 1854 hr. Sundown times during the observation period began at 1922 hr and ended at 1853 hr (Figure 5). The mean spawn time for the eight-fish group was 1906 hr (+ 31 min), 12 minutes before sunset (1918 hr). The mean time of spawning for the five-fish group was 1924 hr (+ 10.1 min), 31 min after sunset (1853 hr).

Activity patterns were noticeably different between the sexes. In the late afternoon (1700–1800), females were observed swimming, most frequently near the top of the tank. By 1900, females were less active and their abdomens began to swell. As time progressed, the genital papilla of females with swollen abdomens began to protrude (Figure 7). Males were also less active in the late afternoon, becoming more active as the spawning period approached. During courtship, fe-


Group Spawn
♂
♀
♂
♂
♂
♀
♂
♂
♂
♂
♂
♀
♂
♂
♀
♂
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♀

Fig. 4. Diagrammatic representation of *Paralabrax maculatofasciatus* group spawn from courtship to gamete release.

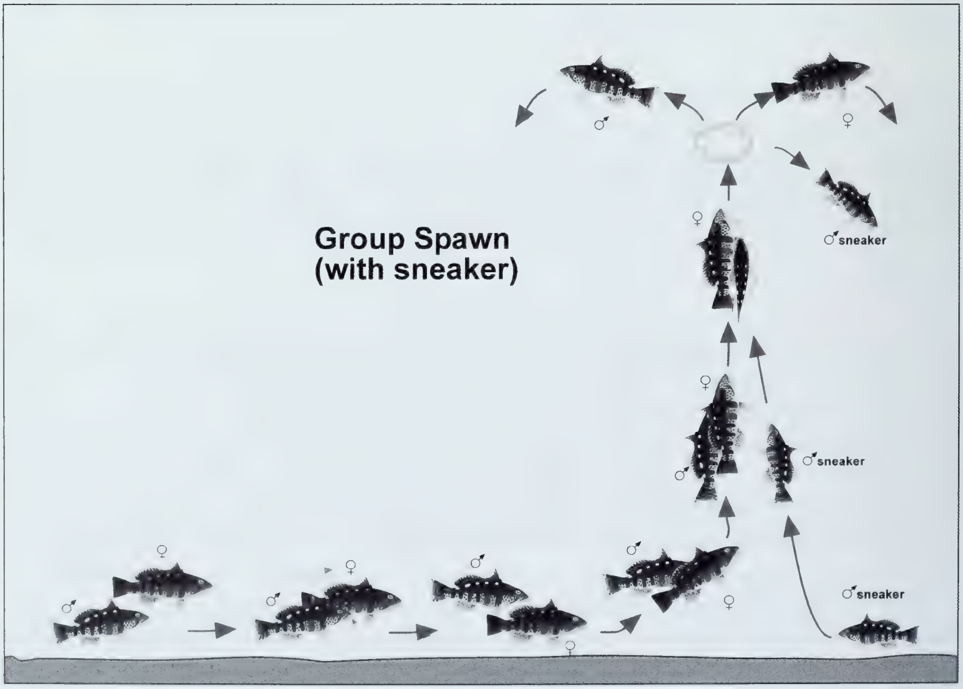
Group Spawn
(with sneaker)
♂
♀
♀
♂sneaker
♀
♂
♂sneaker
♂
♀
♂
♀
♂
♂
♀
♀
♂sneaker
♀

Fig. 5. Diagrammatic representation of group spawning in *Paralabrax maculatofasciatus* involving a sneaker. The courtship begins as a pair courtship that is later interrupted by a sneaker that joins as the original pair make their vertical turn to begin the spawning rush towards the surface.

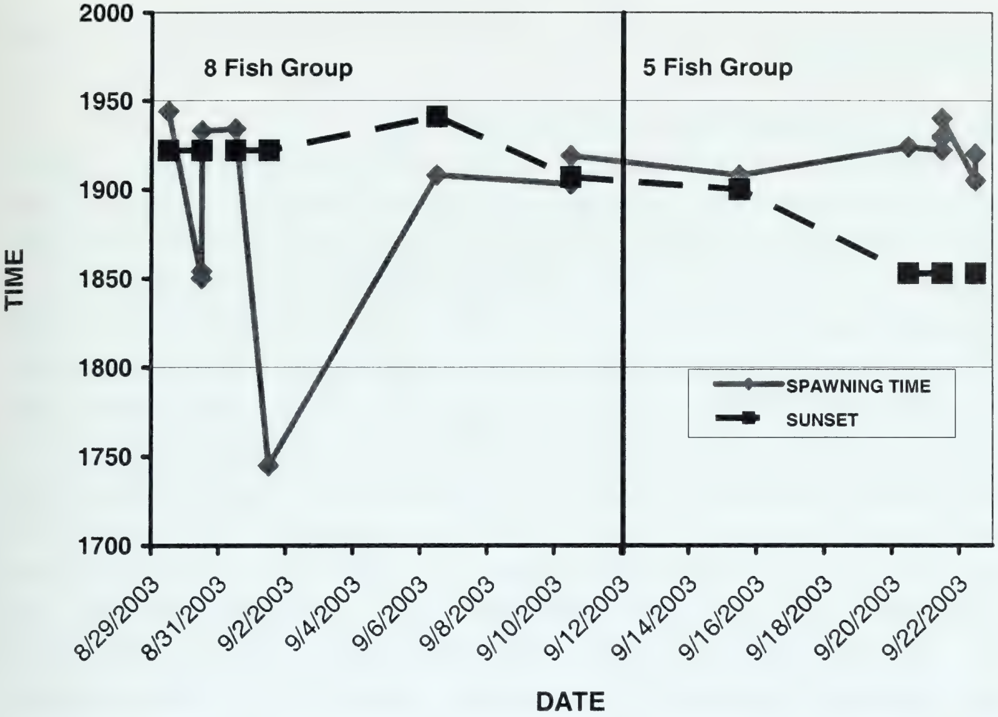

Fig. 6. Spawning and sunset times for the T3 tank observations.

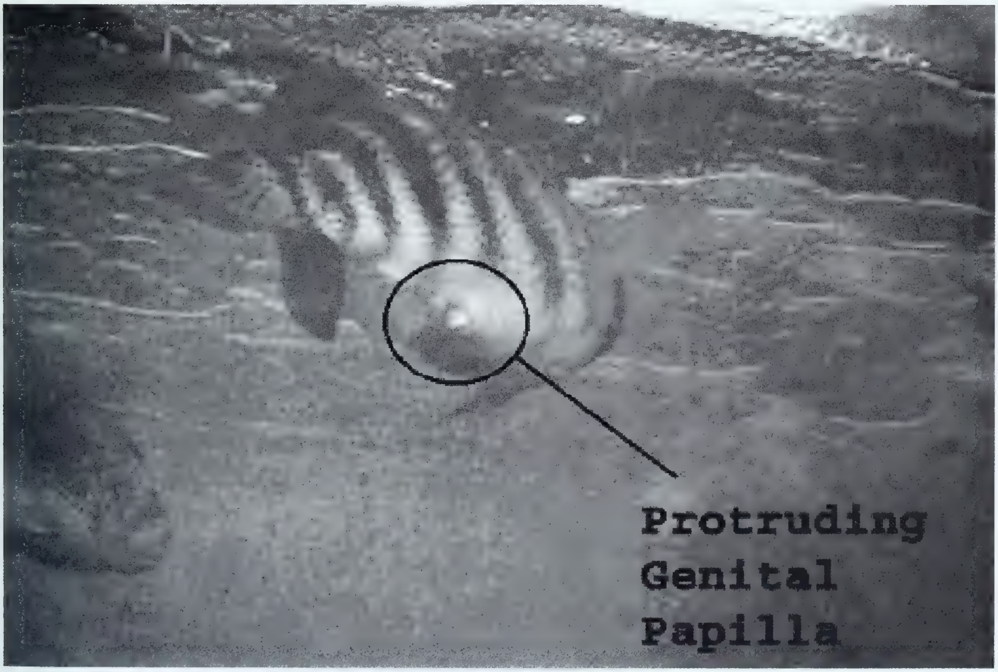
Protruding
Genital
Papilla

Fig. 7. A large gravid female of *Paralabrax maculatofasciatus* with genital papilla protruding from abdomen prior to being courted by an active male.

males were observed hovering, most often near the bottom, while males began approaching them.

Observations on Spawning Modes and Group Size

Overall, 34 spawning bouts were observed in all three tanks. Eleven of these spawns were observed in T1 (large group = higher density), of which 10 were characterized as group spawns with only one pair-spawning event. Only three agonistic interactions were observed in the T1 group, all lasting less than one minute. Sneak spawning was common (Figure 4), occurring in three of the ten recorded group spawns.

Five spawning events were observed in T2 (small group = lower density). All were pair spawns (Figure 1), with the same male involved in all spawns. This male was observed actively excluding other males, and on three occasions, was observed chasing a subordinate that was engaged in courtship activities with a female. Ten agonistic interactions were observed in T2. A single, dominant male was observed in all of the combative activities, with one other male involved most often (80%) with the dominant male. The interactions between these two males were not limited to spawning periods, and were observed at various times throughout the day. Confrontations between these two males in T2 ranged in duration from short (<1 min.) to very long (>1 hr) with one of the two ending the contest by leaving the area. Most encounters began with a dorsal fin flare and color contrast flash, but could quickly progress into a face off, jaw wrestling, charging and chasing, and finally, in some cases, one fish biting the other.

Eighteen spawning events were observed in T3 with various group densities. Sixteen of the 18 spawning events were pair spawns while two were group spawns involving only two males and one female. Neither of the group spawns included sneakers as both males were observed participating in courtship through the spawning rush. Eleven spawning events were observed when eight fish were in the tank, while seven were witnessed with a group of five fish.

Both pair and group spawning was observed in the eight-fish group in T3. However, pair spawning was more common in this group (9 of 11 spawns). The same male was observed actively courting females when the male could be clearly identified by physical characteristics. Male-male aggression was observed once in the eight-fish group, and three female-female agonistic events were also recorded. Female-female interactions involved a gravid female (swollen abdomen) and a presumably inactive female (not swollen).

When five fish were present in T3, only pair spawning was observed. In this case, all spawns involved the same male, with all females of the group observed to spawn at least once. No agonistic activity was observed in this group.

Discussion

Allen et al. (1995) first documented sexual dichromatism in spotted sand bass as males with high contrast dark bars over a white background with a white chin, whereas females were overall darker with dark bars over a medium toned green-gray background with a yellow chin. These patterns are enhanced during reproductive activities with males accentuating the high contrast, while the females gradually developed a darker pattern with less contrast between bars and general background. Only during active spawning do the differences disappear as both males and females take on the high contrast patterns normally seen in males only.

Ephemeral color changes have been documented in other serranids (Gilmore and Jones 1992; Erisman and Allen 2005a; Sala et al. 2003). Kodric-Brown (1998) suggests reproductively related ephemeral color changes in fish may assist in coordinating the activities by signaling the breeding state of the participants. In the current study, male and female spotted sand bass were observed to spontaneously alter their color patterns in response to agonistic challenges, reproductive approaches, and spawning rushes. Gilmore and Jones (1992) found similar modifications to occur in scamp (*Mycteroperca phenax*) and gag (*M. microlepis*). Similarly, Erisman and Allen (2005a) observed both seasonal and ephemeral color change in kelp bass related to reproduction. He noted that during courtship, males accentuated their normal breeding coloration whereas females maintained or darkened their coloration. Unlike kelp bass, female spotted sand bass take on a high contrast color pattern, similar to the male pattern, during the final spawning rush.

Spotted sand bass exhibited many similarities in courtship and spawning behavior to that of a partially sympatric congener, the kelp bass (*Paralabrax clathratus*; Erisman and Allen 2005b). Chief among these was the extensive contact between male and female during courtship and spawning in both species. Also, females from both species showed a dramatic decrease in activity when gravid, while the males greatly increased their activity levels during spawning periods. Moreover, definitive color changes occurred in both sexes for both species of *Paralabrax* during courtship and spawning, with an accentuation of the color patterns normally present to indicate reproductive state. The primary difference between the spawning behaviors of the congeners was the occurrence of multiple mating strategies in spotted sand bass.

Shapiro (1987) concluded that inter- and intrasexual behavior was responsible for inducing sex change in the hermaphroditic wrasse, genus *Thalassoma*. Relative size and behavioral interactions of males within a spawning aggregation were believed to be the dominant stimuli for sex change in protogynous fishes (Shapiro 1987). The size-advantage model (Ghiselin 1969), for the evolution of protogynous hermaphroditism, predicts that large males prevent small males from engaging in spawning behaviors, but allow small females to reproduce. Thus, it is advantageous for an individual to be female while small, and change sex when larger (Warner 1984). Warner and Hoffman (1980) detailed the effect of local population size on the effectiveness of male-dominated reproduction in *Thalassoma lucasanum,* and found local population size to be strongly correlated to the effectiveness of male reproductive dominance through territorial defense. In low-density populations, large terminal-phase males were capable of excluding smaller males from females. As population density increased, the ability of terminal-phase males to exclude small males from spawning decreased as tactics such as sneak (streak) spawning increased in frequency (Warner and Hoffman 1980). When the increased energy expenditure for defense of females by a terminal-phase male exceeds the reproductive advantage, the selective advantage of sex change is lost by the individual and, collectively, within the breeding population.

Munoz and Warner (2003) recently modified the size advantage hypothesis for protogynous hermaphroditism. The authors indicated that large females may defer sex change to smaller individuals due to a skew in the size fecundity relationship.

According to Munoz and Warner (2003), the relationship between female body size and fecundity may be logarithmic rather than linear. This predicts that the fecundity of a single, large female may be equivalent to that of all remaining females in a population. In such a case, sex change may not present a reproductive advantage. In addition, sperm competition from sneaker males, which may lessen the dominate male's paternity, further lessens the evolutionary advantage gained by sex change from a large, highly fecund female to a dominant male.

In spotted sand bass, small, low density groups were observed to pair spawn in 91% of observed spawning events. The large, higher density groups engaged in group spawning in 91% of observed events. The size-advantage model for protogynous hermaphrodites predicts that breeding aggregations with relatively low fish density would allow dominant males to monopolize females for spawning activities via pair spawning. Selection would favor a protogynous sex allocation in this case. Conversely, a large, high density breeding aggregation would select for group spawning strategies, as reported for *Paralabrax clathratus* (Erisman and Allen 2005b), where a large dominant male would be incapable of excluding other males from engaging in spawning activities. During brief field observations of a large, dense spawning aggregation in Guerrero Negro, Baja California Sur, Hovey (pers comm[3]) noted only group spawning to occur. Warner and Hoffman (1980) reported similar results for blueheaded wrasse, *Thalassoma bifasciatum,* where terminal phase males comprised 12% of the population on small reefs but only 1% on larger reefs. Small reefs with low fish density supported pair-spawning aggregations, whereas large reef aggregations with high fish density were observed to group spawn exclusively. Furthermore, Warner (1982) indicated that sex change in the rainbow wrasse, *Thalassoma lucasanum,* was rare, only occurring at low population densities. Low density groups of spotted sand bass may very well show the same pattern (Hovey and Allen 2000).

In summary, the size-advantage model seems to explain the maintenance of multiple mating strategies of (at least captive) spotted sand bass quite well. Behavioral observations of captive fishes in low and high density groups indicated that spawning aggregation density may have a significant influence on the sex allocation of this facultatively protogynous hermaphrodite. In small, low density spawning groups, pair spawning with a single dominant male was the prominent mating strategy observed, thereby making a sex change from female to male selectively advantageous. Large, high density groups primarily displayed group spawning, in which case sex change may offer little or no selective advantage. At higher density levels, large males were not observed to exclude smaller males from engaging in reproductive activities, perhaps suppressing any reproductive advantage that may be gained through post-maturational sex change.

Acknowledgments

The authors would like to thank M. Gardner, M. Miller, B. Tufts, D. Warren, D. Bottinelli, J. Williams, M. Salomon, as well as G. Cetrulo, L. Elkins and the interns of the S. E. A. Laboratory in Redondo Beach, CA for their assistance. We also acknowledge the technical assistance of B. Victor and T. Hovey. This manuscript was greatly improved by the comments of D. Pondella, M. Franklin, R.

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Espinoza, and B. Erisman. This project was generously supported by the following: facilities were provided by the S.E.A. Laboratory in Redondo Beach, CA which was founded by Southern California Edison and the Earth Island Institute, PADI Project A.W.A.R.E. Foundation, Sigma Xi Grant-in-aid, California State University, Northridge Office of Graduate Research and Sponsored Projects through the Graduate Equity Fellowship and Thesis and Performance Grant, and a California State University, Northridge Corporation Student Project Committee grant.

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Bull. Southern California Acad. Sci.
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A New Late Miocene Species of Sciaenid Fish, Based Primarily on an *in situ* Otolith from California

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Abstract.—A new species of sciaenid, *Seriphus lavenbergi* sp. nov., is described from the late Miocene Yorba Member of the Puente Formation, southern California. The holotype is represented by an incomplete disarticulated skull with the right saccular (= sagitta) otolith *in situ,* an extremely rare occurrence. This is the earliest known geological occurrence of *Seriphus* and represents a second species within the genus. It is hypothesized that the ancestor of *Seriphus* emigrated from the Gulf Stream of the Atlantic into the Pacific via the Panama Seaway and the genus evolved entirely in the eastern Pacific.

During the spring of 1969, students from Rio Hondo College (Whittier, California) collected fossils from a late Miocene marine site referred to locally as "Chalk Hill" in the western Puente Hills, City of Industry, California. Mr. Melvin Caskey, former Associate Professor of Geology at Rio Hondo College, allowed one of us (RWH) to examine some of the material collected. Among the specimens was a small block of diatomaceous shale, which contained a crushed, incomplete neurocranium of a fossil fish that still contained both saccular (= sagitta) otoliths *in situ.* We describe a new species of the sciaenid genus *Seriphus* based on this specimen. Previous to this report, *Seriphus* was considered monospecific (see discussion) with its earliest geological occurrence in the late Pliocene (Fitch and Reimer 1967).

The family Sciaenidae represents a strongly provinicalized worldwide group of nearshore fishes containing some 270 extant species (Nelson 1994). This family is confined to shallow, coastal, and estuarine environments with a few freshwater taxa. These fishes are most abundant in tropical and subtropical areas, diminishing in more temperate zones. Sciaenids are absent from the Ryukyu Islands, New Zealand, and Pacific Oceanic Island groups (Sasaki 1989). They are also absent from the North Sea and only a single species is recorded in southern Australia (Schwarzhans 1993). This strongly suggests that the open ocean regions and cold extreme temperate zones were effective barriers to the distribution of this group.

The fossil record of *Seriphus* is confined to the extant species *S. politus* Ayres, 1860, and is represented only by isolated otoliths from the Plio-Pleistocene of California. The earliest geological occurrence of *Seriphus* is from the Fernando Formation, late Pliocene (Fitch and Reimer 1967). *Seriphus politus* has also been reported from the Timms Point Silt, early Pleistocene (Fitch 1968), from the late Pleistocene Sand Pedro Sand, and overlying Palos Verdes Sand (Kanakoff 1956; Fitch 1964, 1966, 1967, 1970). Fitch (1970) reported *S. politus* from the Crannell

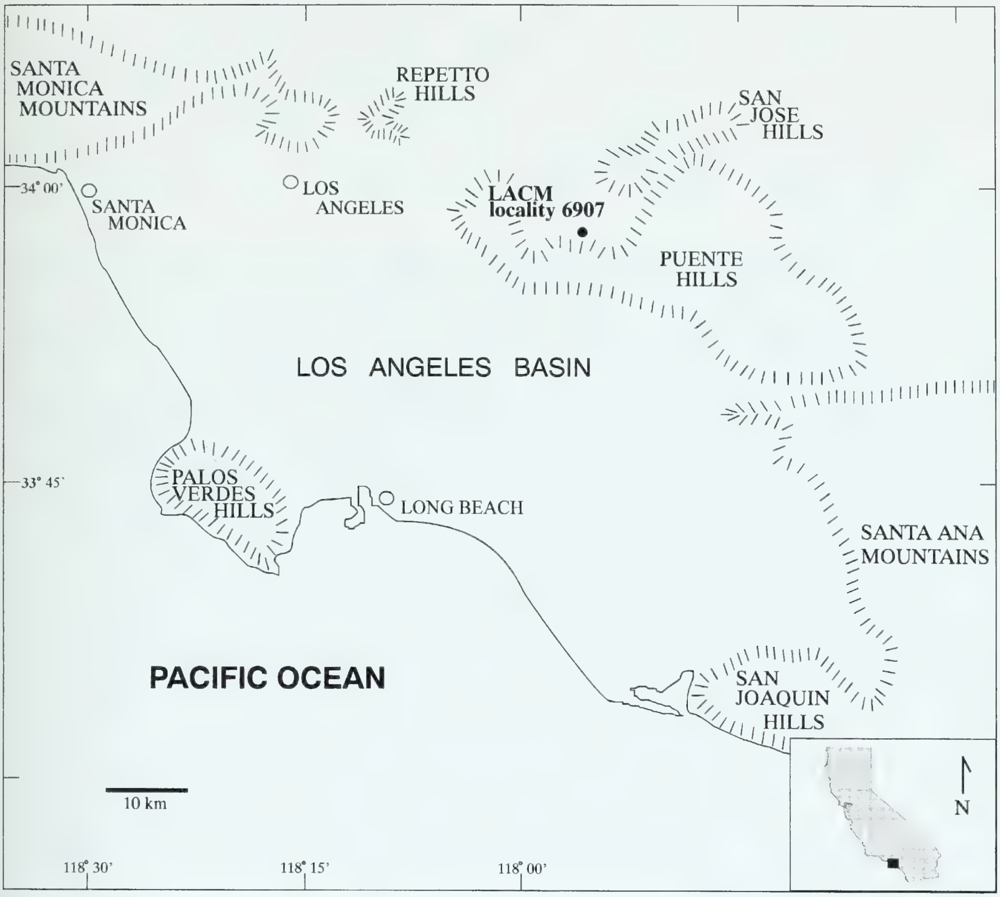
SANTA MONICA MOUNTAINS
REPETTO HILLS
SAN JOSE HILLS
34° 00'
SANTA MONICA
LOS ANGELES
LACM locality 6907
PUENTE HILLS
LOS ANGELES BASIN
33° 45'
PALOS VERDES HILLS
LONG BEACH
SANTA ANA MOUNTAINS
PACIFIC OCEAN
SAN JOAQUIN HILLS
10 km
N
118° 30'
118° 15'
118° 00'

Fig. 1. Map of the Los Angeles basin indicating type locality (LACM locality 6907) of *Seriphus lavenbergi,* sp. nov. (LACM 55484), holotype, late Miocene, Yorba Member of the Puente Formation, California.

Road locality near Arcata, northern California and referred this site to be age-equivalent to the late Pleistocene Palos Verdes Sand of southern California. We have determined these deposits to represent the late Pleistocene Battery Formation and constitutes the northern most fossil occurrence of *Seriphus.*

Locality and Geology

The locality, Natural History Museum of Los Angeles County (LACM) locality 6907, was an approximately 10 m vertical exposure on a small west-facing hill in the western Puente Hills, City of Industry, Los Angeles County, California (Fig. 1). This site is located approximately 31 km east of downtown Los Angeles, but was largely destroyed by construction activity in the 1980's. The stratigraphic thickness of the section is 100 m and is composed of finely laminated diatomaceous shale interbedded with gray siltstone and fine dark mudstone deposited on a submarine fan at bathyal depths (Durham and Yerkes 1964; Yerkes 1972; Critelli et al. 1995). Durham and Yerkes (1964) and Yerkes (1972) have assigned this interval to the lower part of the Yorba Member of the Puente Formation. The

Puente Formation was named by Eldridge and Arnold (1907) for exposures in the Puente Hills in the eastern Los Angeles basin, and they recognized a lower shale member, an intermediate sandstone member, and an upper shale member. Daviess and Woodford (1949) informally divided the formation into four members, and subsequently, Schoellhamer et al. (1954) formally named the members: The La Vida Member, the Soquel Member, the Yorba Member, and the Sycamore Canyon Member.

Recently, some confusion about the naming of the Puente Formation has arisen by the assignment of the La Vida, Soquel, and Yorba members to the Monterey Formation and by the elevation of the Sycamore Canyon Member to formational rank (Dibblee 1995; 2001). The Puente Formation is considered by most workers equivalent in age to the upper portion of the Monterey Formation; however, it is distinctly different in lithology and depositional environment. The Monterey Formation consists of siliceous hemipelagic shale deposited at bathyal depth (Pisciotto and Garrison 1981), whereas the Puente Formation consists of more terrigenous sediments derived from the southeastern San Gabriel Mountains deposited as turbidites on submarine fans at bathyal depths (Critelli et al. 1995). Thus, we use Yerkes' (1972) terminology for the purposes of this study.

Based upon benthic foraminiferans, Durham and Yerkes (1964) placed a late Miocene (upper Mohnian) age to the Yorba Member of the Puente Formation. Benthic foraminiferan ages have been found to be time transgressive in the Cenozoic rocks of the Pacific coast of North America and are not, by themselves, reliable age indicators relative to ages derived from planktonic microfossils (Prothero 2001). Micropaleontological studies at the locality have yielded diagnostic diatom floras that confirm the late Miocene age. The diatoms are assignable to the *Thalassionema schraderi* Zone, which indicates an age of 8.6–7.6 Ma (J. D. Stewart, pers. comm.).

The Chalk Hill locality has produced a large, as yet undescribed, ichthyofauna dominated by mesopelagic forms with additional epipelagic as well as nearshore taxa (Table 1). A single specimen of the deep sea anglerfish *Acentrophryne* has been reported from the Chalk Hill area (Pietsch and Lavenberg 1980). Other megafossils recovered include an odontocete, an unidentified bird, algal remains, and terrestrial spermatophyte leaves (L. G. Barnes, pers. comm.; J. D. Stewart, pers. comm.). Invertebrates collected include *Delectopecten pedroana* Trask, *Mytilus* sp., *Lepas* sp., and an unidentified shrimp. Probable marine mammal coprolitic material has also been collected.

Material and Methods

Recent comparative materials used in this study are from the collections of the Department of Ichthyology, LACM, and includes skeletons and otoliths of Recent sciaenids. Additional comparative materials came from an otolith collection of one of the authors (RWH).

The holotype of *Seriphus lavenbergi,* sp. nov. (LACM 55484), is catalogued and housed in the collections of the Department of Vertebrate Paleontology, LACM. The holotype was discovered by splitting the diatomaceous shale along bedding planes using small hand tools in the field and was damaged in the process. This method of recovery often damages the specimens because the skeleton splits between the two sides of the shale. Additional preparation, using a fine needle

Table 1. Late Miocene ichthyofauna at LACM locality 6907 Pomona Freeway Chalk Hill, Yorba Member of the Puente Formation, California. Data from Fitch (1969), Pietsch and Lavenberg (1980), J. D. Stewart pers. comm., and personal observation.

Chondrichthyes	
Lamnidae	*Isurus oxyrinchus* Rafinesque, 1810
Cetorhinidae	*Cetorhinus* sp.
Osteichthyes	
Clupeidae	*Ganolytes cameo* Jordan in Jordan and Gilbert, 1919
	Ganolytes sp.
	Xyne grex Jordan and Gilbert, 1919
Atherinidae	*Atherinops* sp.
	Atherinopsis sp.
Argentinidae	*Argentina* sp.
Bathylagidae	Genus and species not determined
Gonostomatidae	*Cyclothone* sp.
Sternoptychidae	*Argyropelecus* sp.
Chauliodontidae	*Chauliodus eximius* (Jordan and Gilbert in Jordan, 1925)
Myctophidae	*Lampanyctus* sp.
	Genus and species not determined
Linophrynidae	*Acentrophryne longidens* Regan, 1926
Moridae	Genus and species not determined
Serranidae	*Paralabrax* sp.
Carangidae	*Decapterus* sp.
Sciaenidae	*Lompoquia* sp.
	Seriphus lavenbergi sp. nov. (this paper)
Zaphlegidae	*Thyrsocles kriegeri* (Jordan and Gilbert, 1919)
Scombridae	*Sarda* sp.
	Scomber sp.
Pleuronectiformes	Family not determined

and a dissecting microscope, was required to carefully remove the fragmented left saccular otolith. This otolith had been crushed, inner face down, on top of the right otolith, and it was removed to expose the underlying diagnostic inner surface of the right otolith for study.

Morphological terms used in the general description follow Nolf (1985), Sasaki (1989), and Schwarzhans (1993). Linear measurements were made on an EPOI Shopscope optical micrometer. Otolith measurements for the Sciaenidae (Fig. 2) follow Schwarzhans (1993), and characters and their definitions for features of the saccular otolith are described below. Measurements used for proportional ratios on the inner face include the following: otolith length (L) is the greatest anterior to posterior length; otolith height (H) is the greatest dorsal to ventral height; ostium length (OL) is taken from the anterior edge of the ostium to the posterior most extension of the ostium, including the postostial lobe if present; ostium height (OH) is the greatest dorsal to ventral height of the ostium with the otolith in natural position; caudal length (CL) is measured from the dorsal edge of the cauda, at the dorsal caudal joint and extending to the posterior most extension of the dorsal caudal margin; length of horizontal portion of the cauda (X) is measured from the caudal joint of the ventral caudal margin and extending to the posterior most extension of the ventral caudal margin; length of down turned portion of cauda (Y) is from the highest point of the ventral caudal margin to the

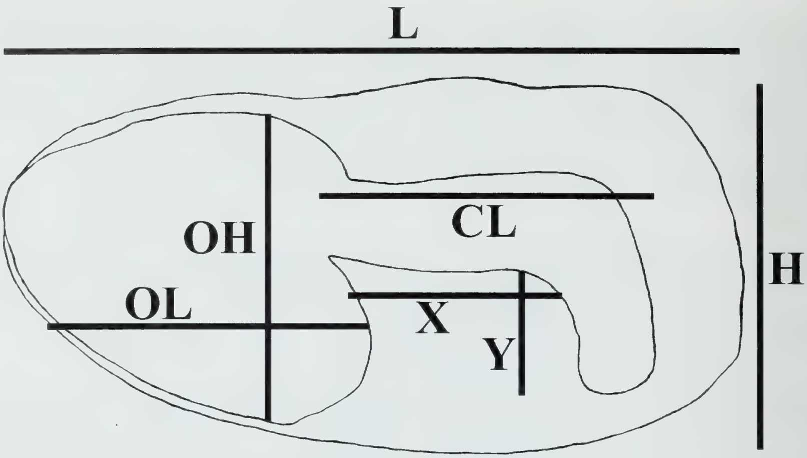

Fig. 2. Inner face of generalized sciaenid saccular otolith with measurements used for proportional ratios. **Abbreviations**: **cl,** cauda length; **h,** otolith height; **l,** otolith length; **oh,** ostium height; **ol,** ostium length; **x:y,** caudal curvature index (cci). Follows Schwarzhans (1993).

posterior most point of the cauda termination. The measurement used for proportional ratios from lateral view is otolith thickness (T), which is the greatest inner face to outer face thickness taken in dorsal view.

Systematic Paleontology

Class Actinopterygii (sensu Nelson, 1994)
Division Teleostei (sensu Nelson, 1994)
Order Perciformes (sensu Johnson and Patterson, 1993)
Family Sciaenidae Cuvier, 1829
Subfamily Sciaeninae Gill, 1861
Genus Seriphus Ayres, 1860
Seriphus lavenbergi sp. nov.
Figs. 3–4; Table 2

Holotype.—LACM 55484, incomplete disarticulated skull with right saccular otolith *in situ* (Fig. 3).

Additional specimens.—The holotype is the only known specimen.

Type locality.—LACM locality 6907, Pomona Freeway Chalk Hill, City of Industry, Los Angeles County, California, USA; 117° 54′ 41″ W. longitude and 33° 59′ 28″ N. latitude, La Habra 7.5 quadrangle (U.S.G.S).

Horizon.—The Yorba Member of the Puente Formation, late Miocene described by Durham and Yerkes (1964) and Yerkes (1972).

Etymology.—The holotype is named in honor of Robert J. Lavenberg, Curator Emeritus, Department of Ichthyology, LACM, who along with the late John E. Fitch and one of the authors (RWH) collected and initiated the first research on the Chalk Hill ichthyofauna. We acknowledge his friendship, assistance, and contributions to the study of fossil and Recent fishes.

Diagnosis.—*Seriphus lavenbergi,* is distinguished from *S. politus* in the following combination of characters for the saccular otolith: 1) a more elongate overall

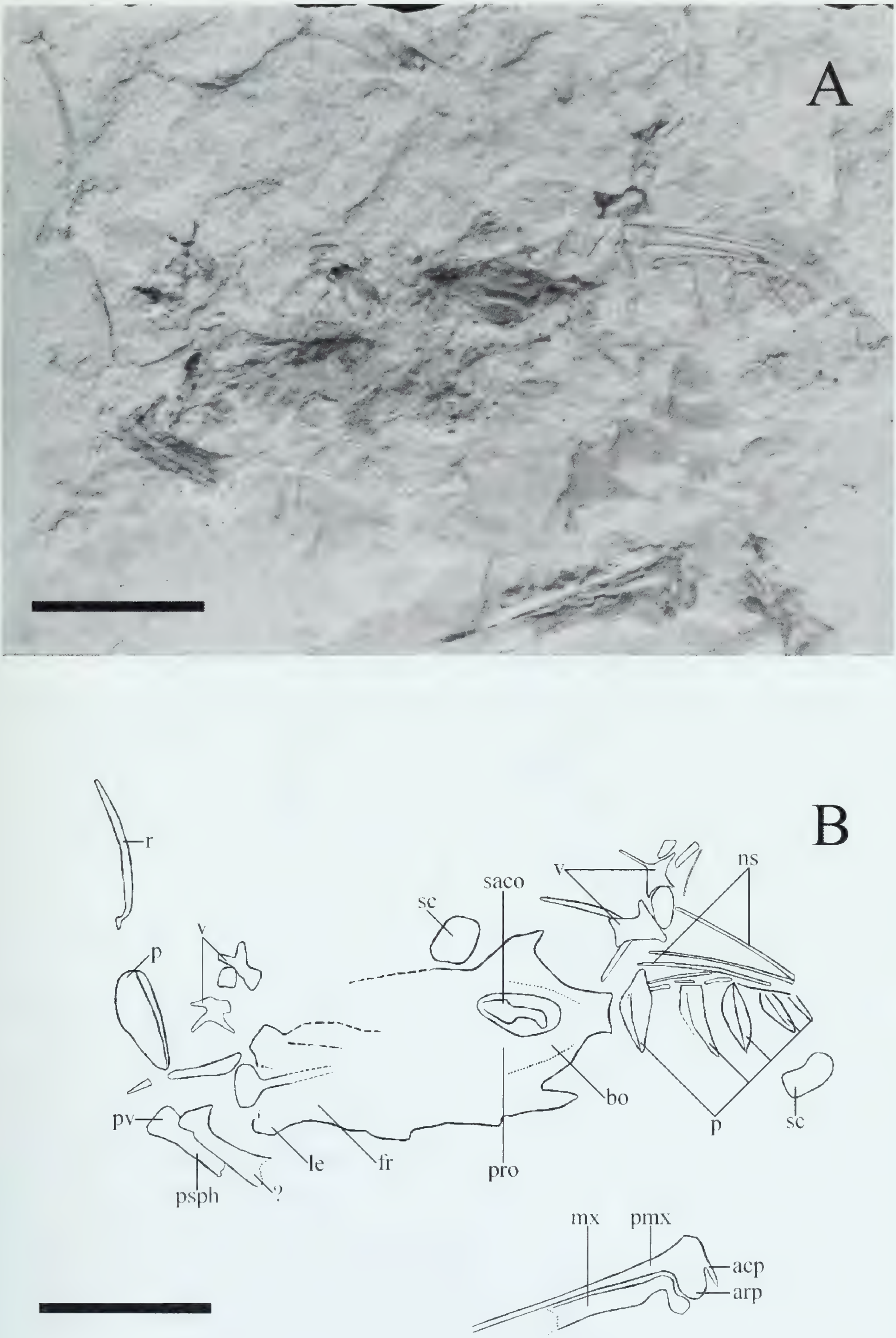

Fig. 3. Photograph (**A**) and illustration (**B**) of disarticulated skull with right saccular otolith *in situ* of *Seriphus lavenbergi,* sp. nov. (LACM 55484), holotype, late Miocene, Yorba Member of the Puente Formation, California. **Abbreviations**: **acp,** ascending process; **arp,** articular process; **bo,** basioccipital; **fr,** frontal; **le,** lateral ethmoid; **mx,** maxilla; **ns,** neural spine; **p,** pterygiophore; **pmx,** premaxilla; **pro,** prootic; **psph,** parasphenoid; **pv,** prevomer; **rb,** rib; **saco,** saccular otolith; **sc,** scale; **v,** vertebra. Scale bar equals 2 cm.

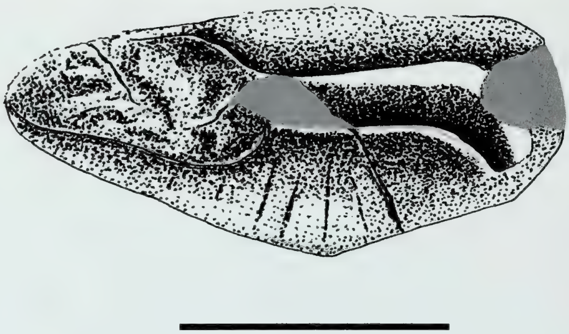

Fig. 4. Drawing of right saccular otolith of *Seriphus lavenbergi,* sp. nov. (LACM 55484), holotype, late Miocene, Yorba Member of the Puente Formation, California. Gray areas represent missing portions of the otolith. Scale bar equals 5 mm.

shape (Fig. 4); 2) a low, nearly horizontal dorsal rim (Fig. 4); 3) a more blunted, nearly vertical posterior rim (Fig. 4); 4) a longer more anteriorly tapering ostium (Fig. 4); 5) a lower caudal curvature index (2.2 vs. 3.7 in *S. politus*; Table 2); and 6) the posterior cauda is more gently flexed posteroventrally (Fig. 4). The new species also differs from *S. politus* in the following: a premaxilla with a much longer alveolar process; and a maxilla that is strongly constricted between the anterior condyle and the posterior extension of the maxillary.

Discussion.—The most diagnostic feature of the holotype is the saccular otolith, which has a broad, flat, shallow ostium. The cauda is narrow and horizontal with a curved posterior section. The sulcus is strongly homosulcoid with both the rostrum and antirostrum absent. These features are sufficient to place this specimen within the family Sciaenidae. The sub-ovate otolith with a subangular ventral margin, ellipitical ostium, and posteroventrally-bent posterior cauda is characteristic of the genus *Seriphus.*

Description.—The holotype of *Seriphus lavenbergi* (Fig. 3–4) is a disarticulated incomplete skull with the right saccular otolith *in situ.* The specimen is preserved as brown bone in white diatomaceous shale.

The neurocranium measures 48.20 mm in length and 21.24 mm at greatest width. The preserved elements of the skull are difficult to interpret because of damage. The frontals and lateral ethmoids appear to be preserved in ventral view. The paired triangular frontals are by far the largest bone in the skull roof and account for the anterior half of the neural cranium. The lateral ethmoids are paired, moderately thick and projecting lateroanteriorly, forming the anterior wall of the orbits. The edentulous prevomer is short and expands laterally. It is detached and preserved lateroanteriorly of the neurocranium. The nasals do not appear to be preserved in the holotype. The thick, flattened parasphenoid is detached and preserved in ventral view anteriorly of the neurocranium. The anterior parasphenoid is attached to the prevomer. The paired prootics are large and broken, attached posteroventrally to the incomplete enlarged basiocceptals.

The upper jaw consists of a maxilla and a premaxilla. The bone surfaces are all smooth without noticeable ornamentation. The premaxilla bears well-developed ascending, articular, and postmaxillary processes. The ascending process is a thin blade-like structure and is higher than the articular process. The articular

Table 2. Comparison of measurements and proportional ratios of the saccular otolith between species of *Seriphus*. **Abbreviations**: **l**, otolith length; **h**, otolith height; **t**, otolith thickness; **ol**, ostium length; **oh**, ostium height; **cl**, caudal length; **x**, horizontal portion of cauda; **y**, down turned portion of cauda; **x**:**y**, caudal curvature index (cci). See text and Fig. 2 for definition of abbreviations. Measurements are in mm.

	l	h	t	ol	oh	cl	x	y	l:h	h:t	cl:ol	ol:oh	cci
S. lavenbergi													
Holotype (LACM 55484)	10.3	5.1	—	4.8	2.6	4.8	2.9	1.3	2.0	—	1.0	1.8	2.2
S. politus													
Mean	9.61	5.48	2.21	4.43	2.64	5.03	3.31	0.9	1.75	2.49	1.13	1.67	3.77
Standard Deviation	0.85	0.13	0.24	0.25	0.09	0.53	0.22	0.15	0.14	0.23	0.08	0.05	0.67
Coefficient of Variation	8.85	2.45	10.88	5.64	3.69	10.63	6.84	16.97	8.12	9.34	7.37	2.76	17.79
Maximum	10.9	5.7	2.7	4.9	2.8	5.7	3.5	1.1	1.9	2.8	1.2	1.8	4.7
Minimum	8.1	5.3	2.0	4.2	2.5	4.0	3.0	0.7	1.4	2.1	1.0	1.6	3.0
Number = 7													

process is large and rounded, while the alveolar process is narrow and incomplete. The postmaxilla process is also incomplete. The ventral edge of the alveolar process has a narrow row of small, uniform conical teeth.

The maxilla is incomplete, and only the anterior portion is exposed. The maxilla has a distinct head with two condyles and a laterally flattened shaft. The dorsal-ventral width of the shaft is strongly constricted just posterior of the condyles.

Other associated skeletal material includes four disarticulated abdominal vertebral centra with the parapophysis either poorly preserved or broken. Neural spines are either obscured by matrix or incomplete. Two pleural ribs are present. An isolated partially articulated segment of four dorsal fin pterygiophores are preserved near the posterior end of the neurocranium. The pterygiophores are bisegmental with well-ossified stays. Pterygiophores are broad, blade-like, and increase in size posteriorly. Two additional detached pterygiophores are present, anterior and posterior of the neurocranium.

Numerous isolated scales and scale impressions on the slab are scattered around the neurocranium and are of the typical sciaenid type. They are ctenoid with the focus positioned posterior to the center of the scale. There are 12–13 anterior (basal) radii.

The right saccular otolith (Fig. 4) is moderately elongate with a total length of 10.3 mm and a greatest height of 5.1 mm. Measurements and proportional ratios of the otolith are given in Table 2 and Fig. 2. The dorsal rim is low, flat, and nearly horizontal with a slight undulation. The anterior end is sharply rounded, lacking both rostrum and antirostrum, and the ventral rim is deep and strongly angular, reaching greatest depth just posterior of the vertical midline of the otolith. The posteroventral margin is short and angled posterodorsally, with the posterior margin blunted. The ostium is large, broad, shallow, subelliptical, and elongated, tapering anteriorly. The area of the precaudal depression is not adequately preserved for description. The cauda is narrow, with its anterior long and nearly horizontal. The posterior cauda is greatly flexed posteroventrally and terminates near the posteroventral margin.

Discussion and Conclusions

The genus *Seriphus* is generally acknowledged as monospecific, with *S. politus* as the only included species. Recently, Schwarzhans (1993) incorporated an additional extant species, *Cynoscion striatus,* within *Seriphus.* This assignment was based solely on similarities in otolith morphology and excluded the differences in osteology and soft body anatomy upon which the relationships of the modern sciaenids are based. A phylogenetic analysis for the Sciaenidae by Sasaki (1989) that used morphological, osteological, and myological evidence concluded that *Seriphus* is broadly separated from *Cynoscion* by possessing the following characters: an enlarged and anteriorly located toothplate on the pharyngobranchial 2, the flexor ventralis externus fades into the flexor ventralis, the basiphenoid is separate from the parasphenoid ventrally, a dentary foramen is present, there is a secondary reversal from an enlarged and anteriorly located tooth plate on pharyngobranchial 2, the posterior dorsal fin spines are not exposed, and the soft dorsal and anal fin bases are of equal length. Sasaki's (1989) phylogenetic analysis placed *Seriphus* and related genera near *Cheilotrema* and *Cillus.*

The saccular otolith of *S. politus* and *Cynoscion striatus* display some superficial similarities, however, a closer examination as part of this study revealed significant differences. The otoliths of *C. striatus* differ from *Seriphus* by being more elongate and subrectangular. They are considerably thicker with a small, more elliptical ostium. The anterior cauda is relatively longer, and the posterior cauda is extremely short and sharply curved. These features are more consistent with the interspecific variation seen in the species of *Cynoscion*. Based on these observations and the differences in the osteological and soft-bodied anatomy, we consider the placement of *C. striatus* within *Seriphus* untenable. Thus, we recognize only a single extant species within *Seriphus*.

The occurrence of *S. lavenbergi* in the late Miocene Yorba Member of the Puente Formation suggests that *Seriphus* appears to have evolved entirely in the subtropical eastern Pacific during, or prior to, the late Miocene. The Sciaenidae display pronounced provincialism with most genera confined to a specific bioprovince. The greatest diversity and highest number of species within the Sciaenidae primarily concentrate in two distinct areas of the world: Tropical America (on both Pacific and Atlantic sides) and the Indo-West Pacific, particularly along the coasts from India to China. A third more isolated endemic bioprovince occurs along the tropic West Africa coast. These areas may represent the evolutionary centers for sciaenid radiation and dispersal (Schwarzhans 1993). In his analysis of the monophyletic groups within the Sciaenidae, Sasaki (1989) noted that the family possibly originated in a restricted area of the New World (= eastern Pacific and western Atlantic) with successive dispersals extending the range of the family and increasing the diversity of the genera and species.

The North American fossil record of the Sciaenidae strongly suggests that Tropical America was the possible major evolutionary center for this family. The earliest geologic occurrence of the family is from the middle to late Eocene Gulf Coast region of North America (Koken 1888; Frizzell and Dante 1965; Breard and Stringer 1999; Nolf 2003; Nolf and Stringer 2003). Eight fossil sciaenid species have been described with an additional specimen assigned to a Recent species. Of these, five have been recognized as valid by Schwarzhans (1993). The fauna is dominated by very plesiomorphic genera that includes *?Umbrina pseudoradians, Frizzellithus gemma, Eokokenia epporrecta, Jefitchia claybornensis,* and *Jefitchia copelandi*. None of the sciaenids from the Eocene through Miocene Gulf Coast region display any ancestral relationship to *Seriphus*. Dispersal of the family into the eastern Pacific from the Gulf Coast region occurred by way of the Panama Seaway sometime prior to the early Miocene. Assuming fossil sciaenids had similar ecological preferences as extant sciaenids, they probably used the existing coastline of North America to radiate into the eastern Pacific. Final closure of the Panama Seaway with the uplift of the Isthmus of Panama occurred about 3.5 Ma (Coates et al. 1992) and divided a former single bioprovince in two.

Otolith-rich Eocene deposits along the eastern Pacific of North America show a conspicuous absence of sciaenids. They first appear in the early Miocene (ca 23 Ma) of the west coast of North America within the Jewett Sand Formation in central California (Huddleston, pers. obs.). This small poorly preserved fauna includes several undescribed sciaenids. By the late early Miocene (ca 16.7 Ma), the family was well established in the eastern Pacific, and this is reflected in the occurrence of several thousand sciaenid otoliths representing more than a dozen different taxa from the late early Miocene Olcese Sand of central California

(Clarke and Fitch 1979). This is the largest and most diverse sciaenid population known from the fossil record, yet none of the taxa display any ancestral relationship to *Seriphus*. This strongly suggests that Seriphus evolved sometime between the early and late Miocene.

Until recently, otoliths *in situ* were considered an extremely rare occurrence. Nolf (1985) noted only 23 fossil taxa of otoliths associated with skeletal material in which the otoliths were sufficiently preserved to be taxonomically useful. The fossil fish record in California is restricted to either the numerous faunas based on isolated otoliths or the relatively few faunas based solely on skeletal material. Recent work in southern California by the authors has revealed a surprising number of localities with skeletal remains associated with otoliths. These occurrences appear to be more frequent than previously reported. The reason for this is not known at this time, but it has opened up possibilities that will help provide a more complete picture of California Cenozoic fishes for future studies. At present, three localities are known within California that have at least some specimens preserved with otoliths. These include the Chino Hills, Puente Hills (this paper), and the northern Los Angeles basin. Of these, the Chalk Hill locality is unique in being the only North American diatomaous deposit where otoliths are preserved with skeletal remains (Huddleston and Takeuchi 2002). Specimens with otoliths *in situ* provide an invaluable bridge in the dichotomy that currently exists in the nomenclatural taxonomy between taxa based entirely on isolated otoliths and skeletal material lacking otoltihs.

Acknowledgments

We thank M. Caskey, former Associate Professor of Geology, Rio Hondo College, California, who brought to the attention of one of the authors (RWH) the specimen described in this paper. R. F. Feeney and J. A. Seigel (Department of Ichthyology, LACM) provided access to osteological specimens and otoliths of extant sciaenids. We greatly benefited from discussions with L. G. Barnes and J. D. Stewart (Department of Vertebrate Paleontology, LACM). Comments by C. A. Shaw, and reviews by H. L. Fierstine and G. L. Stringer greatly improved the clarity of this paper. K. E. Nakashima assisted with figure 3. Preliminary results of this project were presented at the 62nd Annual Meeting of the Society of Vertebrate Paleontology and previously published in abstract form (Huddleston and Takeuchi 2002).

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Accepted for publication 16 March 2005.

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An abstract summarizing in concise terms the methods, findings, and implications discussed in the paper *must* accompany a *feature article. Abstract should not exceed 100 words.*

A feature article comprises approximately five to thirty typewritten pages. Papers should usually be divided into the following sections: abstract, introduction, methods, results, discussion and conclusions, acknowledgments, literature cited, tables, figure legend page, and figures. Avoid using more than two levels of subheadings.

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McWilliams, K. L. 1970. Insect mimicry. Academic Press, vii+326 pp.

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CONTENTS

An Annotated Bibliography of References to Historical Distributions of Pronghorn in Southern and Baja California. David E. Brown, Jorge Cancino, Kevin B. Clark, Myrna Smith, and Jim Yoakum 1

Observations on the Mating Behavior of Captive Spotted Sand Bass (*Paralabrax maculatofasciatus*). Eric F. Miller and Larry G. Allen 17

A New Late Miocene Species of Sciaenid Fish, Based Primarily on an *in situ* Otolith from California. Richard W. Huddleston and Gary T. Takeuchi 30

Cover: Wild antelope in the Vizcaino Desert of central Baja California. Kevin B. Clark.

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ISSN 0038-3872

SOUTHERN CALIFORNIA ACADEMY OF SCIENCES

BULLETIN

Volume 105

Number 2

BCAS-A105(2) 43–90 (2006)

August 2006

Southern California Academy of Sciences

Founded 6 November 1891, incorporated 17 May 1907

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Date of this issue 22 August 2006

♾ This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

Bull. Southern California Acad. Sci.
105(2), 2006, pp. 43–58

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A Mid-Holocene Fauna from Bear Den Cave, Sequoia National Park, California

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Abstract.—Test excavation of floor fill deposits in the first room in Bear Den Cave, Sequoia National Park, produced fossiliferous sediments down to at least 40 cm depth. Radiocarbon analysis of charcoal from this layer indicates an early-middle Holocene age of 7220 CAL BP. The fossil accumulation represents prey recovered from generations of ringtail (*Bassariscus astutus*) dung. Microvertebrate remains include salamanders, lizards, snakes, and mammals. The recovery of *Aneides ferreus/vagrans* from early-middle Holocene deposits in Bear Den Cave is a first for this species group. Equally interesting is the recovery of *Plethodon* sp. Neither taxa live in the Sierra Nevada today. The fossil-rich deposits of Bear Den Cave indicate that future paleoecological studies will be productive in Sequoia National Park.

The National Park Service (NPS) is currently inventorying and monitoring its biological resources in an attempt to document the observed changes, understand if they are natural or human-caused, and understand the driving mechanisms. The most logical way that the NPS can determine how much change is acceptable is to compare the rate of change today with that of the rest of the Holocene (the most recent 11,000 years), including that period just prior to the arrival of Anglo-Americans. These data exist in caves that have preserved the environmental changes over several thousand years.

"The limestone caves of California have been the object of much fruitful investigation[s]. . . In purely paleontologic studies the cave faunas are of unusual importance, representing as they do an aspect or zone of [amphibian, reptilian, and] mammalian life not preserved in the more common lacustrine, fluviatile and alluvial accumulations" (Stock 1918:462). Few late Pleistocene fossil localities were known in 1918, with the vast majority such as the tar seeps of Rancho La Brea and Carpinteria (among others) located in southern California. Faunas from caves were equally as rare and included Samwel, Potter Creek, and Hawver caves. Stock's statement above is still true today. Additional caves have been investigated since the time of Stock. Although important, most of these are located in the arid, lower elevations of San Bernardino County, southern California (e.g., Schuiling Cave [Downs et al. 1959; Jefferson 1983] and Kokoweef Cave [Goodwin and Reynolds 1989; Bell and Jass 2004]). Only a few cave faunas have been described from mountainous California, such as Eagle Feather Cave, Fresno County (Cole 1983; Mead et al. 1985).

A wealth of pollen and macrobotanical data has been recovered from woodrat middens (*Neotoma* nesting debris piles) and sediment cores extracted from meadows and lake bottoms from a multitude of locations within the Sierra Nevada Range (Anderson and Smith 1994; Woolfenden 1996; Anderson et al. 1997). From these studies a reconstruction is emerging of climate and vegetation changes during the late Pleistocene and through the Holocene. What have yet to be adequately examined are the changes in vertebrate communities, and of particular interest is how they responded to climate and vegetation changes. Here we report on the small microvertebrate fauna of early-middle Holocene age recently recovered from Bear Den Cave, Sequoia National Park, Tulare County. Bear Den Cave was selected for assessment because it was known to be a repository of skeletal remains and likely would record vertebrate changes through time.

Methods

Bear Den Cave is in a marble formation within the steep watershed of Yucca Creek, part of a western drainage (North Fork Kaweah River) of the Sierra Nevada Mountains, Sequoia National Park (Figure 1). The cave is at 1460 m (4790 ft) elevation with a north-northwest exposure about 30 m above the current streambed (approximately 36° 35′N, 118° 49′W). Entrance to this small cave of two rooms is via a short crawlway. The first room measures about 7 by 12 m with 3–4 m ceilings and is the site of our Test Pit A (approximately 17 m from the entrance). The excavation near the cave wall by TWM (NPS permit SEKI-2002-SCI-37) measured 0.5 by 0.5 m with 5 cm levels and was taken to a maximum depth of 40 cm. Although skeletal elements were found throughout the levels, we used the abundant remains from the 25–30 and 35–40 cm levels in this preliminary study. All sediments were wet sieved through 180 μm mesh screens, dried, and picked of all bone material under 10x magnification.

Results

The fauna of amphibians, reptiles, and mammals recovered from Bear Den Cave is presented in Table 1, with emphasis being placed on the amphibians and reptiles. The characters used to identify each taxon will not be discussed except for the geographically unusual or taxonomically confusing species. All specimens are curated by Sequoia-Kings Canyon National Parks (SEKI). Charcoal fragments were removed from the 35–40 cm depth in Test Pit A. Standard C14 analysis and C13/C12 ratio analysis (−24.0‰) on sample Beta-188747 produced a conventional radiocarbon age of 6260 ± 100 BP. The intercept of the age with the calibration curve produces a calibrated (corrected) age of CAL 7220 BP (one sigma calibration date range: CAL 7410 to 6900 BP).

Salamanders (Amphibia, Caudata)

Identifications of salamander fossils are based on morphologic and phenetic characters observed on vertebrae (in the modern comparative collection at the Laboratory of Quaternary Paleontology, Northern Arizona University) and the characters reported in Wake (1963, 1966). Modern comparative skeletal specimens of salamander used to compare to those from Bear Den Cave are listed in Appendix I. We feel that the morphology of plethodontid vertebrae is not understood well enough at present to conduct an apomorphic approach to identifications.

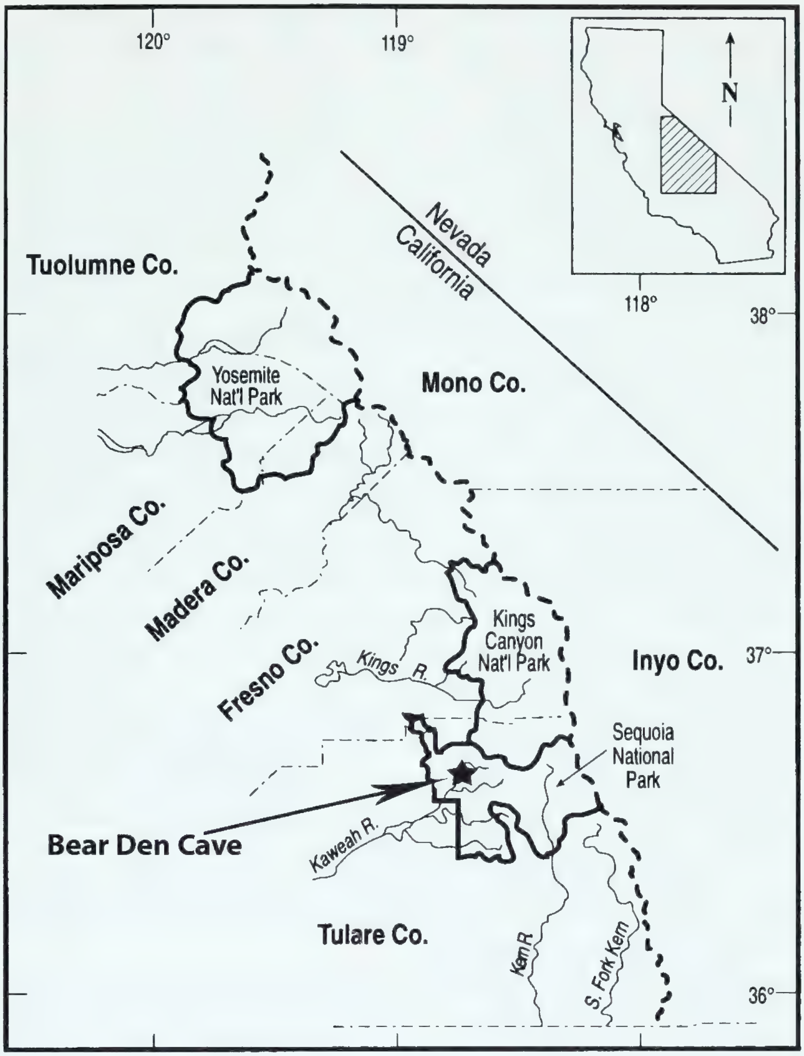
120°
119°
118°
38°
37°
36°
N
Nevada
California
Tuolumne Co.
Mono Co.
Yosemite Nat'l Park
Mariposa Co.
Madera Co.
Fresno Co.
Kings R.
Kings Canyon Nat'l Park
Inyo Co.
Sequoia National Park
Bear Den Cave
Kaweah R.
Tulare Co.
Kern R.
S. Fork Kern

Fig. 1. Map of the southern Sierra Nevada Range of California locating Bear Den Cave in Sequoia National Park. Other nearby parks contain additional late Pleistocene and Holocene biotic remains related to those recovered from Bear Den Cave. Crest of mountain range denoted by dashed line. Adapted from Anderson and Smith (1994).

Because of our phenetic approach, our identifications should be viewed as a best-fit recognition, one that provides a direction for future morphological studies and biogeographical modeling.

One trunk vertebra (SEKI-20167; Figure 2A, B) is identified as cf. *Aneides ferreus/vagrans* (Plethodontidae). *A. ferreus* (clouded salamander) traditionally is known to occur today in coastal forests of northern California and Oregon (Wake 1974, Petranka 1998). Jackman (1998) used molecular data to show that the Oregon populations are *A. ferreus,* and that they are distinct from the California form which Wake and Jackman (1998) place into a different species, *A. vagrans* (wandering salamander). A detailed comparison of the vertebrae has not been conducted, yet Wake and Jackman (1998:1579) note that *A. vagrans* "is similar to *A. ferreus* in general morphology and osteology." Here we will not make a distinction of the two species until further detailed morphological comparisons are conducted.

SEKI-20167 is nearly complete, missing only a portion of the posterior neural arch rise and the lateral extensions of the transverse processes. SEKI-20167 is from an adult individual based on the development of the thickness of the neural arch wall. Because of this and the overall size of the vertebra (see below) SEKI-20167 does not belong to *Ambystoma* (mole salamanders, Ambystomatidae) or *Diacamptodon* (giant salamanders, Dicamptodontidae [Dicamptodontinae of Frost et al. 2006]), which are much larger at adult growth.

The centrum length of SEKI-20167 is 2.2mm and the posterior centrum diameter is 0.9 mm, establishing a centrum ratio (**cr**) of 2.44. The various species of *Aneides* have a range of the **cr** from 1.8 to 2.4. Another plethodontid, *Ensatina,* has a stout vertebra with a **cr** of 2.5. The **cr** of other plethodontids is greater, illustrating their long, slender vertebrae: *Plethodon* (2.9–3.4), *Hydromantes* (3.0–3.9), *Batrachoseps* (3.0–3.5) (**cr** data from Wake 1966).

Although the transverse processes are incomplete on SEKI-20167, they are preserved at the proximal end showing that the diapophysis and parapophysis are likely joined. This is difficult to unequivocally determine as on one side the diapophysis and parapophysis seem not to be joined (i.e., separate processes) and on the other side there is an indication that they may be joined. A complete separation of these processes occurs with *Ensatina,* some species of *Aneides,* most species of *Plethodon,* and *Hydromantes.* If we conclude that SEKI-20167 has a connection at least at the proximal end, then the vertebra does not belong to *Ensatina, Hydromantes,* or some species of *Aneides* or *Plethodon.* There is a complete joining of the processes (proximal end to tip) on some species of *Plethodon* (e.g., *P. elongatus,* Del Norte salamander) and *Aneides flavipunctatus* (black salamander). There is only a proximal joining between these processes on some *Plethodon* and *Aneides ferreus/vagrans.*

The parapophysis is offset caudally from the diapophysis on SEKI-20167. These two processes are directly above each other on *Hydromantes* and *Batrachoseps,* indicating that SEKI-20167 is not either of these two genera. There is no alar expansion to the transverse processes on SEKI-20167, as is found on *Aneides lugubris* (arboreal salamander), *A. flavipuntatus* (to a lesser extent), and *Taricha* (newts, Salamandridae).

The **cr** indicate that the robust SEKI-20167 is likely a member of the genus *Aneides,* and not of the more slender *Plethodon, Hydromantes, Batrachoseps* (possibly including *B. robustus*), or the stout *Ensatina.* The conclusion that the diapophysis and parapophysis processes are joining implies that SEKI-20167 could belong to *Aneides ferreus/vagrans* or some species within *Plethodon.* The combination of the above phenetic characteristics implies that SEKI-20167 is probably *Aneides* and most likely *A. ferreus/vagrans.*

A second trunk vertebra (SEKI-20166) is identified as *Plethodon* sp. (Figure C,D). This vertebra is about 80% complete, missing the haemel arch, posterior cotyle, and left transverse process. The relative thickness of the bone implies a mature individual, or at least not a juvenile. The right transverse process is complete and extends beyond the zygapophysial lateral margin. This process begins straight then smoothly bends to the posterior (not the abrupt bend observed on

Table 1. Fauna (number of identifiable specimens) from Bear Den Cave in Sequoia National Park, California, recorded from sediment layers at 25–30cm depth and 35–40cm depth. Also indicated is whether or not that species, or related species, are known from the current fauna in the Park: x, present; —, not present. Note that the living anurans (frogs and toads), birds, and turtles are not listed below, and only the orders of living (Mod, modern) salamanders, squamates, and mammals that are also recovered in the cave are listed.

Taxon	Mod	25–30	35–40
AMPHIBIA, CAUDATA			
Plethodontidae			
cf. *Aneides ferreus/vagrans*	—	—	1
Batrachoseps gregarius, gregarious slender salamander	x	—	—
B. kawia, Sequoia slender salamander	x	—	—
B. regius, Kings River slender salamander	x	—	—
B. relictus, relictual slender salamander	x	—	—
B. simatus, Kern Canyon slender salamander	x	—	—
Ensatina eschscholtzi, ensatina	x	—	—
Hydromantes platycephalus, Mt. Lyell salamander	x	—	—
Plethodon sp., lungless salamander	—	—	1
Plethodontidae genus et species unidentified	—	—	1
Salamandridae			
Taricha torosa, California newt	x	—	—
REPTILIA, SQUAMATA			
Phrynosomatidae			
Phrynosoma coronatum, coastal horned lizard	x	—	—
Sceloporus graciosus, sagebrush lizard	x	—	—
S. occidentalis, western fence lizard	x	—	—
Uta stansburiana, side-blotched lizard	x	—	—
Scincidae			
Eumeces gilberti, Gilbert's skink	x	—	—
E. skiltonianus, western skink	x	—	—
Teiidae			
Cnemidophorus tigris, western whiptail	x	—	—
Cnemidophorus sp., whiptail	—	—	1
Anguidae			
Anniella pulchra, California legless lizard	x	—	—
Elgaria coerulea, northern alligator lizard	x	—	—
E. multicarinata, southern alligator lizard	x	—	—
cf. *Elgaria* sp., alligator lizard	—	2	—
Boidae			
Charina bottae, rubber boa	x	—	—
Charina sp., boa	—	—	1
Colubridae			
Colubridae genus et species unidentified	—	5	9
Coluber constrictor, racer	x	—	—
Contia tenuis, sharp-tailed snake	x	—	—
Diadophis punctatus, ring-necked snake	x	—	—
Diadophis/Tantilla	—	1	—
Hypsiglena torquata, night snake	x	—	—
Lampropeltis getula, common kingsnake	x	—	—
L. zonata, California mountain kingsnake	x	—	—
Masticophis lateralis, striped racer	x	—	—
Pituophis melanoleucus, gopher snake	x	—	—

Table 1. Continued.

Taxon	Mod	25–30	35–40
cf. *Pituophis* sp., gopher snake	—	—	3
Rhinochelius lecontei, long-nosed snake	x	—	—
Tantilla hobartsmithi, black-headed snake	x	—	—
Thamnophis couchii, Couch's garter snake	x	—	—
T. elegans, western terrestrial garter snake	x	—	—
T. sirtalis, common garter snake	x	—	—
Viperidae			
Crotalus viridis, western rattlesnake	x	—	—
Crotalus sp., rattlesnake	—	1	—
MAMMALIA			
CHIROPTERA			
Verspertilionidae			
Antrozous pallidus, pallid bat	x	—	—
Corynorthinus townsendii, Townsend's big-ear bat	x	—	—
Eptesicus fuscus, big brown bat	x	—	—
Euderma maculatum, spotted bat	x	—	—
Lasionycteris noctivagans, silver-haired bat	x	—	—
Lasiurus blossevillii, western red bat	x	—	—
L. cinereus, hoary bat	x	—	—
Myotis spp. (seven species	x	—	—
Myotis sp.	—	—	1
Pipistrellus hesperus, western pipistrelle	x	—	—
Molossidae			
Eumops perotis, western mastiff bat	x	—	—
Tadarida brasiliensis, Brazilian free-tailed bat	x	—	—
RODENTIA			
Aplodontidae			
Aplodontia rufa, mountain beaver	?	—	1
Sciuridae			
Glaucomys sabrinus, northern flying squirrel	x	—	—
Marmota flaviventris, yellow-bellied marmot	x	—	—
Sciurus griseus, western gray squirrel	x	—	—
Sciurus sp.	—	—	1
Spermophilus beecheyi, California ground squirrel	x	—	—
S. beldingi, Belding's ground squirrel	x	—	—
S. lateralis, golden-mantled ground squirrel	x	—	—
Tamis alpinus, alpine chipmunk	x	—	—
T. amoenus, yellow-pine chipmunk	x	—	—
T. merriami, Merriam's chipmunk	x	—	—
T. minimus, least chipmunk	x	—	—
T. quadrimaculatus, long-eared chipmunk	x	—	—
T. senex, Allen's chipmunk	x	—	—
T. speciosus, lodgepole chipmunk	x	—	—
T. umbrinus, Uinta chipmunk	x	—	—
Tamiasciurus douglasii, douglas' squirrel	x	—	—
Sciuridae genus et species unidentified	—	6	9
Geomyidae			
Thomomys bottae, Botta's pocket gopher	x	—	—
T. monticola, mountain pocket gopher	x	—	—
Thomomys sp., pocket gopher	—	2	1
Heteromyidae			
Chaetodipus californicus, California pocket mouse	x	—	—
Chaetodipus sp., pocket mouse	—	2	2
Dipodomys heermanii, Heermann's kangaroo rat	x	—	—

Table 1. Continued.

Taxon	Mod	25–30	35–40
Castoridae			
Castor canadensis, beaver	x	—	—
Muridae			
Neotoma cinerea, bushy-tailed woodrat	x	—	—
N. fuscipes, dusky-footed woodrat	x	—	—
N. lepida, desert woodrat	x	—	—
Neotoma spp., woodrats	—	37	33
Peromyscus boylii, brush mouse	x	—	—
P. californicus, California mouse	x	—	—
P. maniculatus, deer mouse	x	—	—
P. truei, pinyon mouse	x	—	—
Reithrodontomys megalotis, western harvest mouse	x	—	—
Peromyscus/Reithrodontomys	—	19	27
Microtus californicus, California vole	x	—	—
M. longicaudus, long-tailed vole	x	—	—
M. montanus, montane vole	x	—	—
Microtus sp., meadow vole	—	6	8
Ondatra zibethicus, muskrat	x	—	—
Phenacomys intermedius, heather vole	x	—	—
Dipodidae (Zapodidae)			
Zapus princes, western jumping mouse	x	—	—
Erethizontidae			
Erethizon dorsatum, porcupine	x	—	—
CARNIVORA			
Canidae			
Canis latrans, coyote	x	—	—
Urocyon cinereoargenteus, gray fox	x	—	—
Vulpes vulpes, red fox	x	—	—
Ursidae			
Ursus americanus, black bear	x	*	*
U. arctos, brown bear	x	—	—
Procyonidae			
Bassariscus astutus, ringtail	x	—	—
Procycon lotor, raccoon	x	—	—
Mustelidae			
Gulo gulo, wolverine	x	—	—
Lontra canadensis, river otter	x	—	—
Martes americanus, marten	x	—	—
M. pennanti, fisher	x	—	—
Mephitis mephitis, striped skunk	x	—	—
Mustela erminea, ermine	x	—	—
M. frenata, long-tailed weasel	x	—	—
M. vison, mink	x	—	—
Spilogale putorius, spotted skunk	x	—	—
Taxidea taxus, badger	x	—	—
Felidae			
Puma concolor, mountain lion	x	—	—
Lynx rufus, bobcat	x	—	—

* = found elsewhere in the cave but not in the stratigraphic sections presented here.

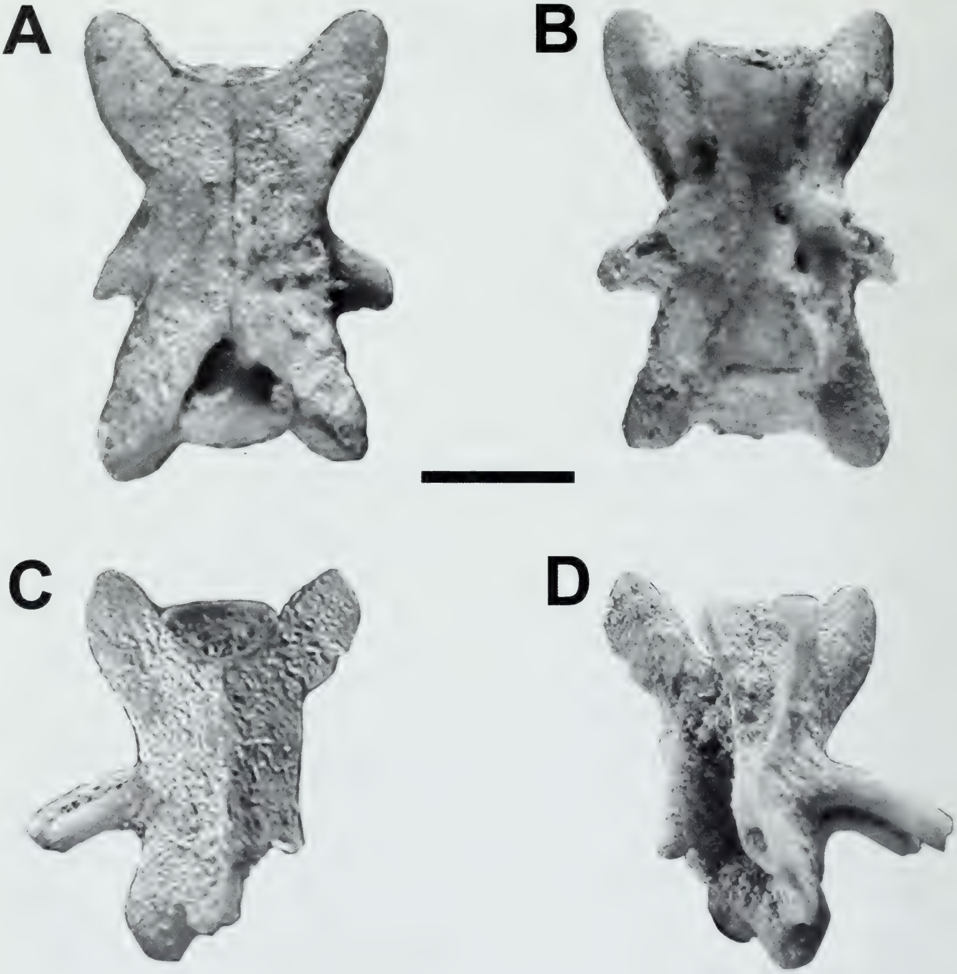

Fig. 2. Photograph of salamander trunk vertebrae from Bear Den Cave. A, dorsal and B, ventral of cf. *Aneides ferreus/vagrans,* SEKI-20167. C, dorsal and D, ventral of *Plethodon* sp., SEKI-20166. Photographs by Sandra L. Swift. Scale equals 1 mm.

Batrachoseps). The diapophysis and parapophysis are connected to the tip, indicating that SEKI-20166 does not belong to *Ensatina, Aneides ferreus/vagrans, Hydromantes,* or some species of *Plethodon.* The parapophysis is offset slightly from the diapophysis indicating that SEKI-20166 is not *Hydromantes* or *Batrachoseps.* Based on this character, SEKI-20166 could belong to some species of *Plethodon* or *Aneides flavipuntatus.* There is no alar expansion, which indicates that SEKI-20166 does not belong to *Taricha* spp., *Aneides lugubris,* or *A. flavipuntatus.* Given these characteristics, SEKI-20166 seems best to belong to a form of *Plethodon,* although which species cannot be determined at this time.

A fragmented sacral vertebra (SEKI-20165) is identified as Plethodontidae genus et species indeterminate. The specimen is only about 50% represented, preserving most of the posterior half, left transverse process and some of the right process. The hyperapophysis is well expanded, which is typical of the sacral vertebra, but SEKI-20165 has a larger-than-usual flaring. *Taricha* species do not have a hyperapophysis. The hyperapophysis is minute on *Rhyacotriton* spp. (torrent salamanders; Rhyacotritonidae), and its neural arch is markedly flattened, completely unlike that area on SEKI-20165. The diapophysis and parapophysis are not divided, indicating that SEKI-20165 is not *Ensatina.* There is no alar expansion, indicating SEKI-20165 is not *Aneides lugubris* or *A. flavipunctatus.* There is not enough of SEKI-20165 to provide an unequivocal identity. It does have similarities with *Aneides ferreus/vagrans* and *Plethodon elongatus.* The proximal end of the diapophysis of SEKI-20165 is more expanded than observed on *Ensatina* and more like *Aneides ferreus/vagrans* and *Plethodon elongatus.*

Lizards and Snakes (Reptilia, Squamata)

As with the salamander vertebrae, most of the lizard bones (SEKI-20172, 20183, 20185) from Bear Den Cave are fragmented due to chewing by a predator; there is no evidence of etching. A fragmented right quadrate and fragmented left dentary are identified as cf. *Elgaria* (Anguidae, alligator lizard). The quadrate (from a large lizard; SEKI-20184a) has the posterior crest only slightly curved, as in *Elgaria,* and not heavily curved as found on *Eumeces* (skinks). The dorsal end of the medial crest is a wider flange as found on *Elgaria* and not the near absence observed on *Eumeces.* All morphological characters observed on the fossil quadrate are distinct from those found on the robust *Phrynosoma coronatum* (coast horned lizard) or large, robust *Sceloporus* (spiny lizard). The dentary of SEKI-20184b is from a large, robust individual; in living *Eumeces* and *Elgaria* this dentary would be from individuals with snout-vent lengths greater than 125 mm. Seven teeth (and placement for an eight) occur along the 5.5 mm fragment. The teeth have a single apex in the middle of the cone, with a slight posterior orientation. This apex on *Elgaria* is also posteriorly oriented whereas it is lingual on *Eumeces.* Teeth on SEKI-20184b are long and slender with parallel sides, and not similar to the blunt-coned, tapering teeth on many phrynosomatids such as *Phrynosoma* or *Sceloporus.* The Mecklian groove on SEKI-20184b is on the ventral surface, as found on *Elgaria* and *Eumeces,* yet unlike that of phrynosomatids. The symphysis is rounded and not pointed as found on *Cnemidophorus* (Teiidae).

A right dentary (SEKI-20171) with bi-conate teeth, pointed symphysis, and lingually-bent bone is diagnostic to a form of *Cnemidophorus.*

One vertebra of the boid snake, *Charina* sp., was recovered from the 35–40 cm level (SEKI-20169). Discussion about the fossil history of *Charina* (including Eagle Feather Cave, Kings Canyon NP) and characters used to identify their vertebrae are provided in Bell and Mead (1996). Although *C. bottae* lives in the region of Bear Den Cave today, and the fossil specimen likely represents this species, we refrain from making a species-level identification until a detailed examination of ontogenetic and serial vertebral variation of all living and extinct forms of *Charina* is completed.

Fourteen colubrid snake vertebrae were recovered (Table 1; SEKI-20170, 20182), that represent both small and large individuals. Three vertebrae (SEKI-20168) were identified as cf. *Pituophis* (gopher snake). Terminology and identifying characters used here are from observations on specimens in the comparative collection in the Laboratory of Quaternary Paleontology, NAU, and from LaDuke

(1991). A small vertebra is identified as *Diadophis/Tantilla* (SEKI-20181). *Diadophis* and *Tantilla* vertebrae are similar, but there are some subtle differences. SEKI-20181 and *Diadophis* have an acute posterior notch of the neural arch (versus obtuse for *Tantilla*). The postzygapophysis on SEKI-20181 and *Diadophis* is only slightly longer than wide (versus distinctly longer than wide for *Tantilla*). The haemel keel is broad, has sloping edges, and flattened ventrally on SEKI-20181 and *Tantilla.* The centrum length of SEKI-20181 is 1.8 mm and the neural arch width is 1.1 mm, providing a ratio of 1.6; this overlaps with both *Tantilla* and *Diadophis.* Additional vertebrae are needed to determine which taxon is represented in the cave, although both species can be found in the region today (Table 1). A single vertebra of the rattlesnake, *Crotalus* was recovered (SEKI-20180), but not identified to species. Today only *C. viridis* is known from the region.

Mammals (Mammalia)

One complete, isolate M3 of a bat was recovered (SEKI-20188). Based on the width of the tooth, SEKI-20188 belongs to the genus *Myotis* and not a genus with a highly antero-posterior compressed M3 (e.g., *Eptesicus* and *Antrozous*). The species is indeterminable. Bats are known to use Bear Den Cave.

A single, distinctive cheek tooth of a mountain beaver (*Aplodontia rufa*) was recovered from the 35–40 cm depth (SEKI-20173). Although this taxon is known to occur today in the Sierra Nevada, it is thought not to live in the immediate area of the cave.

One fairly-complete skull (occipital region missing; M1–2 preserved) of a squirrel (SEKI-20174b) was recovered at the 30–35 cm level. Based on the overall large size, the specimen does not belong to any of the small ground or tree squirrels, but it is not as large or robust as *Marmota* (marmot) or *Cynomys* (prairie dog). The alveolus for the P3 indicates that the tooth was developed, but near vestigial. This feature and the overall size imply the specimen is not *Spermophilus varietatus* (rock squirrel) and thus appears to belong to *Sciurus* (but not *S. arizonensis*; Arizona gray squirrel which lacks the P3). This specimen could not be differentiated from *S. aberti* (Abert's squirrel) or *S. griseus* (western gray tree squirrel), both which have two upper premolars. *S. griseus* is the only tree squirrel to live in the Sierra Nevada today.

Isolated and fragmented squirrel teeth were numerous in both levels of the deposit (Table 1); these were not identified (SEKI-20174a, 20186). Fifteen species live in the region today, including the chipmunks (*Tamias* spp.), ground squirrels (*Spermophilus* spp.), *Sciurus griseus,* flying squirrel (*Glaucomys sabrinus*), and the large *Marmota flaviventris.* A number of the teeth were small and may represent one or more of the *Tamias.* The larger teeth could be from the larger species of *Spermophilus* or *Sciurus. Marmota,* with its conspicuous large teeth, was not recovered from the cave.

Two species of geomyid pocket gophers live in the region today, *Thomomys bottae* and *T. monticola.* Three isolate teeth (SEKI-20179, 20192) were recovered representing this genus. Four teeth (SEKI-20176, 20189) were recovered representing a small heteromyid, either *Chaetodipus* or *Perognathus* (pocket mouse). *Chaetodipus* and the larger, *Dipodomys* (kangaroo rat) are known from the park today.

Teeth of *Neotoma* are the most abundant identifiable fossils from the deposit

(SEKI-20178, 20191; Table 1). *Neotoma cinerea, N. fuscipes,* and *N. lepida* live in the region today. We feel at this time that there are inadequate characters of the dentition to unequivocally identify isolated teeth; therefore, we have not identified the fossils to species. The pattern to the occlusal surface varies from lophs and re-entrant angles that are rounded and obtuse to those that are acute and sharp, which implies that at least two species are represented in Bear Den Cave.

Peromyscine teeth (SEKI-20175, 20187) were also abundant and not identified beyond *Peromyscus/Reithrodontomys* (Table 1). Today four species of *Peromyscus* and one species of *Reithrodontomys* live in the region of the cave.

Isolated, rootless teeth of arvicoline rodents were identified as *Microtus* (SEKI-20177, 20190), but not to species. Today both *Microtus* (three species) and *Phenacomys intermedius* (with rooted teeth) can be found in SEKI (Table 1).

Discussion and Conclusions

Test excavation of floor fill in the first room in Bear Den Cave produced fossiliferous sediments down to at least 40 cm depth. Radiocarbon analysis of charcoal indicates an early-middle Holocene age of 7220 CAL BP. Microvertebrate remains, including salamanders, lizards, snakes, and mammals, were recovered from layers at 25–30 and 35–40 cm depth (Table 1). No skeletal remains of anurans (frogs and toads), birds, large mammals, or carnivores were recovered from the test pit. The cave is occasionally used today by *Ursus americanus* (black bear; Ursidae; skeletal remains were recovered from elsewhere in the cave) as well as *Bassariscus astutus* (ringtail; Procyonidae). The skeletal remains presented here could have been brought into the cave via the collecting behavior of *Neotoma,* which could include the scavenging of raptor (hawk, eagle, owl) stomach pellets. No owl or diurnal raptor roost is known in or near the cave, although several owls and hawks live in the region.

Taphonomy

Most of the bones from the test pit in Bear Den Cave are slightly to highly fragmented, sharp-edged, and show little to no etching due to stomach acid. Diurnal raptors typically will break bones, and their strong stomach acid characteristically etches, dissolves, and polishes the prey skeletal elements. Skeletal elements from owl pellets typically show little to no etching and most of the bones are unbroken (see Andrews 1990). The recovered skeletal elements from Bear Den Cave do not appear to represent remains from any form of raptor. Ringtails are small carnivores that hunt at night, selecting medium to small-sized nocturnal and crepuscular prey within its home range of <600 ha. (Grinnell et al. 1937). The recovery of a fauna composed of only small species and skeletal remains showing broken bones with sharp edges and without significant etching, polishing, or dissolutioning is consistent with prey remains from ringtail dung (Mead and Van Devender 1981). The accumulation in Bear Den Cave appears to represent, at least in part, generations of ringtail dung deposition. Most of the recovered taxa represent only locally procured species, in contrast to the prey species recovered from raptor stomach pellets.

Environments

Today the Sierra Nevada has a Mediterranean-climate with hot arid summers and cool humid winters (Major 1988). Forest occurs above 1200 m elevation with oak woodland grading into ponderosa and ultimately mixed conifer forests above 1600 m. The vegetation today in the watershed surrounding Bear Den Cave (1460 m elevation) includes ponderosa pine (*Pinus ponderosa*), white fir (*Abies concolor*), canyon live oak (*Quercus chrysolepis*), incense cedar (*Calocedrus decurrens*), California bay (*Umbellularia californica*), California nutmeg (*Torreya californica*), big-leaf maple (*Acer macrophyllum*), wood fern (*Dryopteris arguta*) and others on the north-facing, more mesic, slope where the cave is situated. A riparian community occurs in the canyon bottom.

Aplodontia today are uncommon in Sierra Nevada and SEKI, and significantly, are not near the cave today. This medium-sized rodent is more commonly found in humid, densely vegetation areas. Limits to distribution are associated with rainfall and edaphic conditions that promote succulent vegetation and relatively high humidity within its burrows (Voth 1968, Feldhamer and Rochelle 1982, Carraway and Verts 1993). The current climate regime does not permit such an environment to persist near the cave today.

All of the mammals and most of the amphibians and reptiles from Test Pit A are thought to occur today within the hunting distance of a ringtail except for *Aplodontia, Aneides,* and *Plethodon.* The occurrences of cf. *Aneides ferreus/vagrans* and *Plethodon* sp. are an intrigue and puzzle. The characters used in the identifications seem secure enough to determine that the two vertebrae do not belong to any of the salamanders known from Sequoia National Park or nearby region today (Table 1). Indeed, only one species of *Aneides* (*A. lugubris*) is even known from the Sierra Nevada Range (Petranka 1998). *A. lugubris* lives in the northern Sierra Nevada and to the west of the region (Lynch and Wake 1974; Jennings 1996); *A. ferreus/vagrans* lives along the coastal region of northern California and north (Jackman 1998), as does *A. flavipunctatus* (Lynch 1974). Today *A. ferreus/vagrans* is a forest species, typically associated with large logs and talus slopes, and is one of the most arboreal salamanders in North America. Although fossil and subfossil remains of *Aneides* are known (Tihen and Wake 1981; Clark 1985), *A. ferreus* and *A. vagrans* are known only from the modern record. Their recovery from early-middle Holocene deposits in Bear Den Cave is a first for this species group. Equally interesting is the recovery of a vertebra of *Plethodon* sp. No species of *Plethodon* live today in the Sierra Nevada (Petranka 1998).

The salamanders living today in the Sequoia National Park region are either a plethodontid (*Batrachoseps, Ensatina,* and *Hydromantes*) or salamandrid (*Taricha*). Some of these (e.g., *B. gregarius*) can live in areas of intense summer heat and drought (Jockusch et al. 1998). *Ensatina* normally lives in mesic microhabitats; in arid regions, it typically lives only on north-facing slopes. *Hydromantes platycephalus* likely does not currently live in the immediate vicinity of the cave because it requires greater mesic habitats (Adams 1942). *Taricha torosa* can live in mesic forests and in the drier habitats with oak forests, chaparral, rolling grasslands, and the more arid gray pine-blue oak communities of the Sierra Nevada and likely does occur in the vicinity of the cave (Petranka 1998). Although it is not understood specifically which salamanders live today in the immediate vicinity of Bear Den Cave, the vegetation community would imply that the more mesic areas would harbor some *Batrachoseps, Ensatina,* and *Taricha.* Because of the present taxa in the area, we wonder what environment and climate is needed to allow *Aneides ferreus/vagrans* and at least one *Plethodon* species to inhabit the presently somewhat marginal mesic-arid habitat adjacent to Bear Den Cave.

Plethodontid salamanders lack aquatic larvae indicating that free-flowing streams are not a prerequisite in their reproductive strategy (as it is with salamandrids and ambystomatids). The closest locations of living *Plethodon* are along coastal northern California and the mountainous area bordering Oregon (*P. dunni, P. elongatus,* and *P. stormi*; Petranka 1998). *Plethodon elongatus* is usually found in rocky situations within forested areas and seems to be able to withstand somewhat more arid conditions than *P. dunni,* which requires a more humid environment (Leonard et al. 1993). *Plethodon stormi* is typically found in rocky, forested habitats (Leonard et al. 1993). Unless there are traits about the terrestrial ecology and habitat requirements that are not fully understood about these species of *Plethodon,* we speculate that they could possibly live in select mesic habitats of the Sierra Nevada region today. *Aneides ferreus/vagrans* are closely associated with wood decay of Douglas-fir forests (Lowe 1950; Leonard et al. 1993; Jackman 1998). Although it appears that the present climate and habitat around Bear Den Cave is not suitable for *A. ferreus/vagrans,* higher elevations with more moisture and forests could prove appropriate.

These salamanders are not currently found from the southern Sierra Nevada region and their distribution in the very lowest layer of Bear Den Cave suggests they have been missing for some time. Lowe (1950:96) hypothesized that "*Aneides* was a more or less continuously distributed series of populations in the Transcontinental Arcto-Tertiary Flora. . ." It is apparent from the report here that *Aneides ferreus/vagrans* were still present in the southern Sierra Nevada until the mid-Holocene. Approximately 90% of the last two million years in the Sierra Nevada have been wetter and cooler than the last 10,000 years that marks the Holocene (Woolfenden 1996).

The paleoecological record the Sierra Nevada suggests very different climate and vegetation changes throughout the region. Coastal areas of the Pacific slope appear to have been characterized by a marked shift to warmer and drier conditions. Associated with this change in climate was a shift from denser late Pleistocene forest canopies to more open forest and woodlands that were subject to wildfires, which in turn were responsible for even greater opening of the forest and drying of the forest floor habitat (Davis and Moratto 1988).

The west side of the Sierra Nevada 11,000–7,000 BP appears to have been considerably drier than at present (Davis et al. 1985; Davis and Moratto 1988; Anderson 1990; Anderson and Smith 1994, 1997). Early Holocene pollen assemblages are dominated by plants that grow in dry open exposure sites and forests were more open than today. Vegetation on the west side of the Sierra Nevada exhibited a marked Great Basin influence and was similar to contemporary vegetation at higher elevations on the east side of the Sierra crest. Thus, it appears that the early Holocene was drier and cooler than at present and the vegetation more open forest and scrub. Mid-Holocene (7,000–3,000 BP) pollen assemblages indicate a return to a warmer but moister climate and a lower tree line (Davis et al. 1984; Davis and Moratto 1988).

The early Holocene presence of *Aneides* and *Plethodon* in the Sierra Nevada, and subsequent mid-late Holocene disappearance are not easily understood. Today these taxa are distributed in cooler and more mesic forest types typical of the

Pacific Northwest. When placed in the context of our current understanding of the mid-Holocene paleoecology and paleoclimates of the Sierra Nevada, the presence of these salamanders appears to be somewhat anomalous. It would seem that today they are restricted to more mesic forest types than are present in the Sierra Nevada today, yet the present forests are more mesic than their early Holocene counterparts. However, the climate feature both the current coastal habitats of these salamanders have with the early Holocene Sierra Nevada habitats is that they were cooler than contemporary Sierra Nevada sites. Thus, it would appear that temperature is perhaps the critical factor determining the distribution of these taxa.

The fossil-rich deposits of Bear Den Cave indicate that future paleoecological studies will be productive in Sequoia National Park. As such, this park has a unique opportunity to study ecosystem changes over the past several thousand years. What are natural rates of ecosystem change on the Pacific slope of the Sierra Nevada? The answers are preserved in layers of fossils found in caves.

Acknowledgments

We thank Lisa McGinnis for picking fossils from sediments. Sandy L. Swift is appreciated for her help in organizing the collection, sorting the fossils, and photography. Invaluable help with field logistics and general information about the cave and local wildlife were received from Scott Anderson, Joel Despain, Shane Fryer, Tanya Baxter, Dale Ritenour, Rachel Mazur, Harold Werner, Jay Snow, Nick Barth, John Petriello, and Louie Long. Steve Emslie is thanked for his preliminary help in organizing the original excavation plan and being available to identify avian fossils. We greatly appreciate the editorial help and in-depth discussion from D. Whistler and D. Wake.

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Accepted for publication 27 September 2005.

Appendix

Modern comparative specimens of western USA salamanders used to compare with remains recovered from Bear Den Cave. Number of articulate or disarticulated specimens in parentheses.

Ambystomatidae: *Ambystoma tigrinum* (26).

Diacamptodontidae: *Dicamptodon ensatus* (2); *D. tenebrosus* (3).

Plethodontidae: *Batrachoseps attenuatus* (8); *Hydromantes platycephalus* (1; juvenile); *H. shastae* (2); *Aneides ferreus* (1) [based on locality]; *A. flavipunctatus* (4); *A. lugubris* (1); *Ensatina eschscholtzii* (24); *Plethodon dunni* (2); *P. elongatus* (7); *P. vehiculum* (1).

Rhyacotritonidae: *Rhyacotriton variegates* (2).

Salamandridae: *Taricha torosa* (5); *T. granulose* (8).

Bull. Southern California Acad. Sci.
105(2), 2006, pp. 59–75

Densities of Fecal Indicator Bacteria in Tidal Waters of the Ballona Wetlands, Los Angeles County, California

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Abstract.—Densities of fecal indicator bacteria (FIB) represented by total coliforms, *E. coli* and enterococci were measured within tidal channels of the Ballona Wetlands (Los Angeles County) to see if the wetlands act as a sink or source for these bacteria and to measure increases in FIB densities during wet weather. Samples were collected on 10 days over a 1-yr period beginning February 2003 at four sites within the wetlands and one site in Ballona Creek opposite the west tide gate. Incoming flood and outgoing ebb tides were sampled during each sampling event at each station. Water from Ballona Creek may be a significant source of indicator bacteria in the wetlands. Within the tidal channels, densities for total coliforms typically ranged from 10^3–10^4 MPN/100 ml, but ranged up to 10^6 during runoff events. Densities of *E. coli* and enterococci were orders of magnitude less than those measured for total coliforms, generally ranging from 10^1–10^4 for *E. coli,* and 10^1–10^5 for enterococci; greater densities were associated with runoff events. Densities of FIB tended to be up to three times greater during flood than ebb tide conditions depending on the tidal range. This result suggests that more FIB may be entering the wetlands on flood tides than leaving during ebbs, so that these bacteria either are being destroyed, sinking into the tidal channel sediments and plant surfaces, or both. This hypothesis needs to be tested by further identifying other possible FIB sources within the wetlands, and increasing the study design's statistical power to better characterize the flux of these bacteria entering and leaving the wetlands.

Wetlands, both freshwater and salt marsh, are noted for their water purification abilities. For example, suspended sediments will settle into the marsh systems including any associated metal and organic pollutant loads while nutrients will be utilized by plants (Keddy 2000; Mitsch and Gosselink 2000) and feces-derived bacteria are eliminated from the water through destruction by sunlight and other mechanisms (Mayo 1995; Sinton *et al.* 2002). Given these qualities, wetland systems are being used to purify sewage effluents and runoff (Kadlec and Knight 1996; Schueler and Holland 2000).

Conversely, wetlands such as coastal salt marshes can be sources of fecal bacteria depending on degrees of biological activity and input of contaminated runoff from surrounding urban areas. Water contaminated with feces-derived coliform and enterococci bacteria outwelling from coastal marshes has been shown to cause water quality problems at adjacent ocean beaches where swimmers and surfers recreate (Grant *et al.* 2001). If bacterial bathing water standards are not met, then beaches can be posted with advisories or closed resulting in millions of dollars of lost revenues to local businesses. Understanding the sources of fecal bacteria, and their circulation dynamics within coastal marshes, and outwelling to adjacent beaches will help refine regulatory strategies to protect the public.

The goal of this study was to characterize levels of fecal indicator bacteria during different tidal flows within the Ballona Wetlands, a salt marsh located in Los Angeles County along the southern border of Marina Del Rey boat harbor. The central question for this study was: Are concentrations of fecal indicator bacteria greater entering the wetlands from Ballona Creek than leaving the wetland system? To begin addressing this question, densities of fecal indicator bacteria (FIB: total coliforms, *E. coli,* enterococci) were measured in the creek and throughout the wetland during different tidal flows (flood and ebb conditions), and amplitudes (neap vs. spring). To date, FIB measurements have been made in Ballona Creek and Estuary by various storm water monitoring agencies (e.g. LADPW Watershed Management Division: http://ladwp.org/wmd) or runoff research studies (e.g. Dorsey and Lindaman 2004, Stein and Tiefenthaler 2004). Contrastingly, only a single water sample characterizing coliform densities has been collected in the Ballona Wetlands. This work was done in 1998 by a consulting group performing an environmental survey for the Playa Vista development project (Camp Dresser & McKee 1998 as reported in U.S. Army Corps of Engineers 1999). Results reported herein are the first major effort to characterize FIB densities in this wetland system.

Ballona Wetland Study Area

The Ballona Wetlands consist of approximately 180 acres of tidal salt marsh receiving muted tidal flows. It is the last remaining major coastal wetland in Los Angeles County (West 2001). As such, it is surrounded by extensively developed urban areas and impacted by many other human activities. Historically, rail and roadways have fragmented the wetlands since the 1800's. In 1937 The Army Corps of Engineers (COE) and the Los Angeles County Flood Control District constructed the Ballona Creek flood control channel that diverted water from the creek straight to the Santa Monica Bay, thus severely limiting tidal flow to the salt marsh. Presently, water entering the wetlands mainly is from Ballona Creek via a single tidal gate (described below). Other sources of freshwater would include intermittent flows of runoff from residential areas on the southern bluffs, and storm runoff from Culver Blvd. running through the wetland area.

In 2004, several major events occurred that began reversing the history of negative impacts to this wetland. The State of California purchased the remaining 180 acres of wetlands from a developer for eventual restoration, and the COE constructed a new set of tide gates.

Tidal flows within the wetlands are muted. Prior to April 2003 water entered the system through two tidal gates positioned along the southern bank of the Ballona Creek estuary. Both gates were poorly maintained, allowing only a limited amount of tidal flow in and out of the wetlands. The eastern gate was the main gate for the wetlands, allowing in flood and ebb flows. The western gate was a one-way flap-gate allowing only ebb flows to leave the wetlands. Due to corroded hinges, the western gate was frozen in an open position, allowing some flood flows into the wetlands.

In April 2003 the COE replaced the old eastern tide gate with a pair of self-regulating gates allowing a maximum tidal level of 1.1 m to occur (U.S. Army

Corps of Engineers 1999). In November 2003, the COE removed marine growth and corrosion from the hinges of the west tide gate so that it now functions to only allow ebb flows to leave the wetlands. The wetlands now receive flood flows only through the east tide. When the tide turns, ebb flows drain the tidal channels via both the east and west gates.

Wetland and tidal channel monitoring associated with the new tide gate system is being conducted by the City of Los Angeles (Bureau of Sanitation, Environmental Monitoring Division) to document any changes in the biological community associated with this project. If populations of native species are stable, then tidal levels may be increased by 0.1 m. This decision will be made by the California Department of Fish and Game, who, in conjunction with the California Coastal Conservancy, are now developing a restoration plan and implementation strategy to restore the Ballona Wetlands to a more naturally functioning wetland.

Methods

Station Locations and Sampling Times

Water quality measurements and FIB densities were collected along the intertidal channels at five stations during this study (Figure 1). These channels always had some water flow, even during the lowest spring tides. Stations 1 through 4 were located within the wetlands while Station 5 was in Ballona Creek. Both Station 1 and 5 were positioned at the west tide gate. This tidal gate was selected over the eastern gate for its safer access to the tidal channel, and lack of disrupting construction activity. Stations were sampled on a variety of tides ranging from neap to spring tides. Collection days, tidal conditions and ranges are given in Table 1.

Field Procedures

Water measurements and samples were collected within the tidal channels by standing on the bank and reaching out into the channel with a 10-ft rod with either a sensor or a container for a water sample. Only water from the surface was collected for testing. Water quality measurements were collected *in situ* using an YSI 600 QS sonde. At each station the sonde was positioned about 1-ft beneath the water surface, and allowed to equilibrate over about a 5-min period before the suite of measurements were taken. Measurements included water temperature (degrees C), salinity (ppt) and dissolved oxygen (mg/L). A single water sample for bacterial densities was collected in sterile 125 ml polypropylene bottles, placed on ice, and returned to the laboratory for determination of FIB densities within the 6-hr holding time. On three occasions (March 6, 16 and 28, 2003) three instantaneous replicate water samples were collected at each station to measure FIB variability.

Bacterial Determinations

Densities of FIB (total coliforms, *E. coli,* enterococci) were measured using Idexx test kits (http://www.idexx.com) based on enzyme substrate test methods (APHA *et al.* 1998: Standard Methods Section 9223 B.). During dry weather conditions, 10 ml of sample water was added to 90 ml of sterile deionized water mixed with either Enterolert media (for enterococci) or Colilert-18 (for total co-

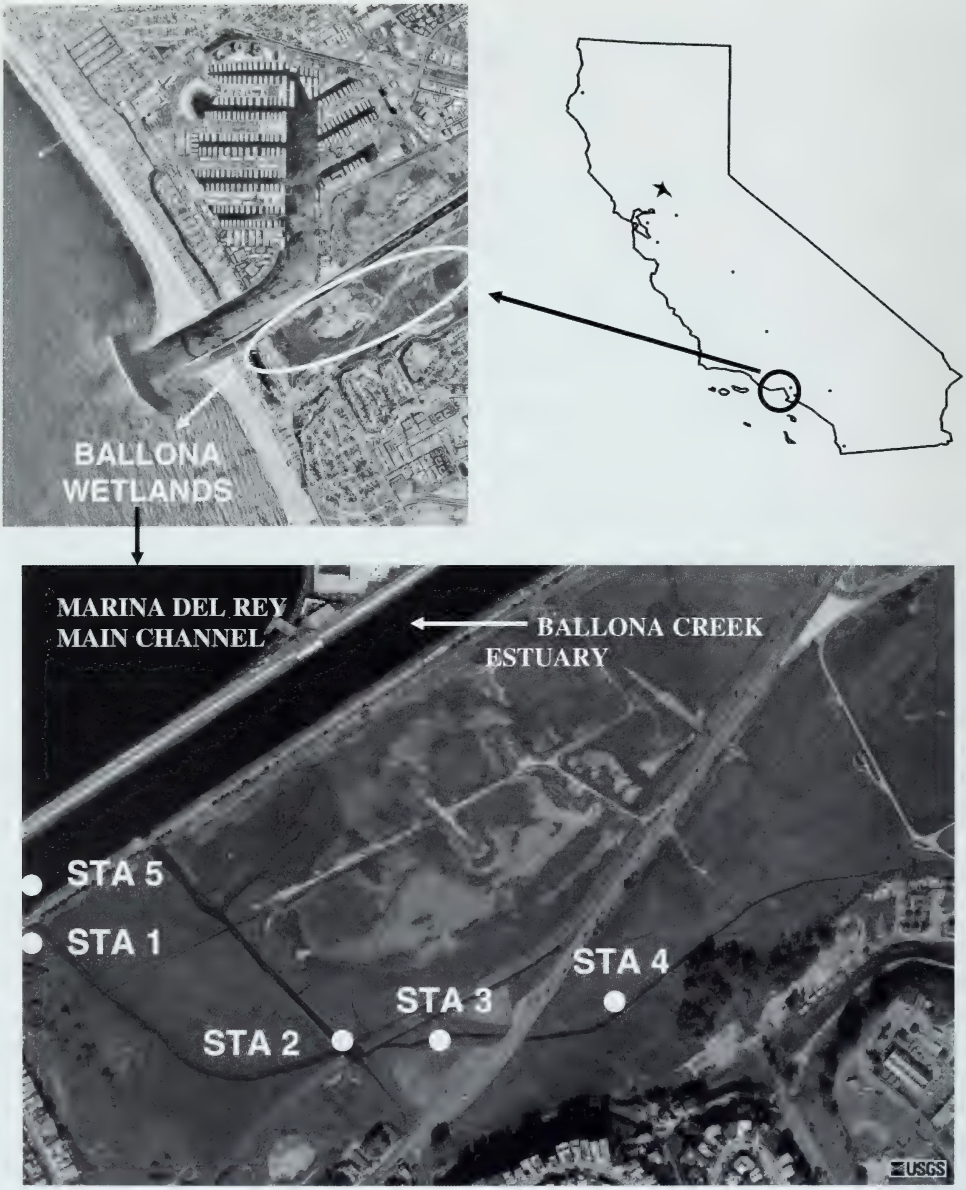
BALLONA
WETLANDS
MARINA DEL REY
MAIN CHANNEL
BALLONA CREEK
ESTUARY
STA 5
STA 1
STA 4
STA 3
STA 2
USGS

Fig. 1. Map of the Ballona Wetlands in relation to Marina Del Rey, California **STA 5** Sampling stations are shown on the aerial photograph (USGS images from: http://edcsns17.cr.usgs.gov).

liforms and *E. coli*). During wet weather, and additional dilution of 1 ml sample in 99 ml of sterile water/media was added allowing for higher FIB densities. The inoculated 100 ml samples then were poured into 97-well QuantiTray-2000 containers, sealed, and transferred to the incubators. The total coliform/*E. coli* trays were incubated for 18–22 hrs at 35°C, and the enterococci trays for 24 hrs at 41°C. Tray-cells showing color changes (yellow for total coliforms, fluorescent

Table 1. Sampling dates, times, and tidal conditions.

	Collection times (hr)			Tidal range (ft)
Date	Flood	Ebb	Tidal heights	
2/21/03	0620–0707	1144–1228	0.9 ft @ 0632 hrs to 3.8 ft @ 1227 hrs	2.9
3/2/03	0837–0949	1325–1416	5.8 ft @ 0833 hrs to −0.7 ft @ 1518 hrs	6.5
3/6/03	0830–0931	1418–1529	4.2 ft @ 1046 hrs to 1.0 ft @ 1649 hrs	3.2
3/16/03*	0605–0714	1244–1327	5.9 ft @ 0727 hrs to −1.0 ft @ 1415 hrs	6.9
3/28/03	0555–0644	1144–1421	5.2 ft @ 0623 hrs to −0.6 ft @ 1317 hrs	5.8
9/30/03	0626–0702	1428–1518	2.2 ft @ 0602 hrs to 5.9 ft @ 1231 hrs	3.7
10/26/03	0600–0708	1232–1329	6.7 ft @ 0856 hrs to −0.9 ft @ 1549 hrs	7.6
11/16/04	1212–1300	1631–1715	4.3 ft @ 1329 hrs to 0.6 ft @ 2136 hrs	3.7
1/18/04	0558–0715	1058–1152	6.3 ft @ 0544 hrs to −1.0 ft @ 1317 hrs	7.3
2/3/04*	0720–0823	1407–1457	5.9 ft @ 0704 hrs to −0.6 ft @ 1427 hrs	6.1

* Wet weather runoff event.

blue for *E. coli* and enterococci) were counted, and MPN/100 ml were determined for each indicator group.

Results

Water Quality Measurements

A summary of the water quality measurements is presented in Table 2. In general, water temperatures were cooler for water flooding into the wetlands from the Ballona Creek estuary with station averages ranging from 13.7–15.2°C. After residing in the wetlands for several hours, mean temperatures were elevated by

Table 2. Statistical descriptions of water quality parameters measured at each station during flood and ebb flows (n = number of measurements collected).

	Flood			Ebb		
Sta	n	Mean ± S.D.	Range	n	Mean ± S.D.	Range
Temperature (°C):						
1	10	14.0 ± 2.4	11.1–18.7	10	17.7 ± 3.2	13.6–20.0
2	10	15.2 ± 1.9	12.4–18.4	11	18.7 ± 2.6	14.7–20.9
3	10	15.0 ± 1.8	12.2–17.5	11	18.5 ± 2.5	14.6–22.4
4	10	13.7 ± 2.9	7.8–18.4	11	18.5 ± 2.6	14.4–22.4
5	8	15.2 ± 2.2	11.8–18.8	9	17.7 ± 1.7	14.6–19.9
Salinity (‰):						
1	10	18.9 ± 9.6	4.8–25.7	10	22.0 ± 9.7	7.5–32.9
2	10	19.3 ± 10.6	1.6–27.3	11	16.6 ± 9.6	1.4–27.5
3	10	17.9 ± 10.6	1.4–23.2	11	15.4 ± 10.1	1.2–26.8
4	10	15.4 ± 10.4	1.3–27.9	11	11.6 ± 8.9	1.14–26.6
5	8	19.1 ± 13.4	0.5–31.44	9	22.0 ± 8.8	6.6–32.4
Dissolved Oxygen (mg/L):						
1	10	4.97 ± 1.80	2.86–7.73	10	8.18 ± 2.83	3.75–13.74
2	10	5.88 ± 2.55	2.46–9.66	11	13.17 ± 6.91	2.86–24.06
3	10	5.45 ± 2.91	1.13–10.06	11	12.10 ± 5.33	4.27–21.26
4	10	6.00 ± 2.71	2.15–10.09	11	12.98 ± 6.88	4.89–23.16
5	8	7.64 ± 2.74	3.43–11.77	8	8.57 ± 3.10	4.78–13.61

2.5 to 4.8°C in water ebbing back into Ballona Creek. Overall temperatures ranged from 7.8–22.4°C with the warmest occurring during spring low-tide ebb flows.

Salinities at the wetland Stations 2–4 generally were brackish with means ranging from 11.6–19.3 ppt. Upper salinity ranges at these sites were measured at about 23–33 ppt during both flood and ebb flows. Within the Ballona Creek estuary (Station 5) and at Station 1, mean salinities were slightly higher ranging from 18.9–22.0 ppt. During ebb flows, the highest values of 22.0 ppt were measured at both these stations. During the three wet weather runoff events (Table 1), salinities ranged from 0.5–2.2 ppt on the flood tides, and 7.5–8.9 on the ebbs, reflecting the influence of runoff from both Ballona Creek and the marsh flats and surrounding bluffs.

Concentrations of dissolved oxygen generally were lower during morning flood tide conditions compared with measurements taken later each day during the ebb flow. Mean concentrations during flood flows ranged from 4.47–7.64 mg/L, rising to 8.18–12.98 mg/L during ebb flows, presumably due to photosynthetic action from plants living in the tidal channels. Some of the lowest values for dissolved oxygen occurred during the flood tidal flow, the lowest occurring at Station 3 (1.88 mg/L on 2-21-03, and 1.13 mg/L on 10-26-03).

Bacterial Densities

Histograms of mean FIB densities for each sampling day for the tidal flows are presented in Figures 2 through 4. These data are summarized in Table 3 where mean densities for each fecal indicator bacteria (FIB) among the five stations during flood and ebb tidal flows are presented. In this table, dry- and wet-weather days were separated, yielding a mean FIB density for each weather situation.

In general, FIB densities in flood flows tended to be greater than those in ebb flows, especially for *E. coli* and enterococci (Table 3). However, this trend was only statistically significant on a few occasions for each FIB group, probably owing to the variability within these data. Densities of FIB groups were tested between flood and ebb flows at each station for the three sampling dates (March 6, 16 and 28, 2003) where replicate samples ($n = 3$) were collected. Of the 15 tests performed, only six yielded significant differences ($p < 0.05$) with densities being greater during flood flows four of the six times (Table 4). During wet weather, all FIB densities increased by one to several orders of magnitude over dry weather densities. During dry weather, FIB densities tended to diminish with increasing salinity (Fig. 5). Overall, correlations were weak, although this relationship was significant for at least one FIB group at each of the wetland stations.

The ratio of bacterial density between flood and ebb flows was determined for each FIB group at each station, and regressed with the tidal ranges over the study period. This approach was used to more closely examine changes in FIB densities over varying tidal ranges, so a FIB Flood:Ebb ratio of >1 would indicate higher densities of FIB on the incoming flood tide. Using only dry weather data, regressions were performed for each FIB group at the five stations. The ratio of Flood:Ebb densities generally diminished with increasing tidal ranges suggesting that FIB densities were nearly equal as the tidal flows moved into spring tide conditions. This relationship was not significant at any of the stations, and was best demonstrated at Station 1 (Fig. 6).

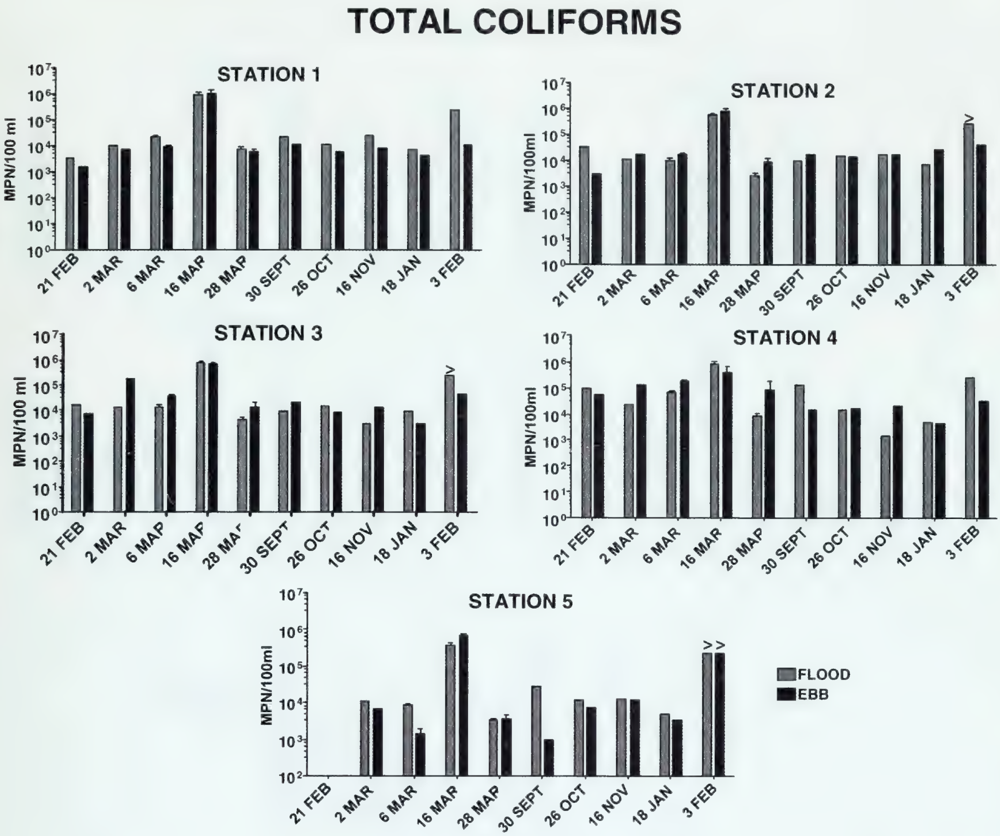

Fig. 2. Densities of total coliforms (MPN/100 ml) during flood and ebb tidal flows, February 2003–2004. The "greater than" symbol (>) indicates densities greater than the method detection level for the dilution used.

Total coliforms. Total coliforms generally ranged from 10^3–10^5 with higher values occurring during the two wet weather runoff events (Table 3). The highest value recorded (1.4×10^6 MPN/100 ml) occurred during wet weather at Station 1 during the ebb flow. Histograms (Fig. 2) among the five stations over the entire sampling period indicated that densities of total coliforms at Stations 5 and 1, positioned in and adjacent to Ballona Creek, respectively, tended to be greater during flood flows (Table 3). This pattern was most consistent at Station 1 where flood densities exceeded ebb densities 90% of the time (Table 5) followed by Station 5 at 70%. This pattern, however, was not statistically significant on the three occasions where replicate samples were taken. Results of t-tests for replicated samples (Table 4) indicated that total coliforms were significantly greater during flood flows only at Station 4 on March 16, 2003 during a runoff event. On this same day, the ebb flow had significantly greater densities of total coliforms at Station 5 ($p = 0.004$), demonstrating the impacts of wetland runoff. Differences in densities of this FIB group during the flood and ebb flows tended to be more similar further into the wetlands at Stations 2–4 where the percentage of samples with flood densities $\geq$ ebb densities ranged from 40–50% (Table 5).

E. coli. Mean densities of *E. coli* generally were greater during flood than ebb

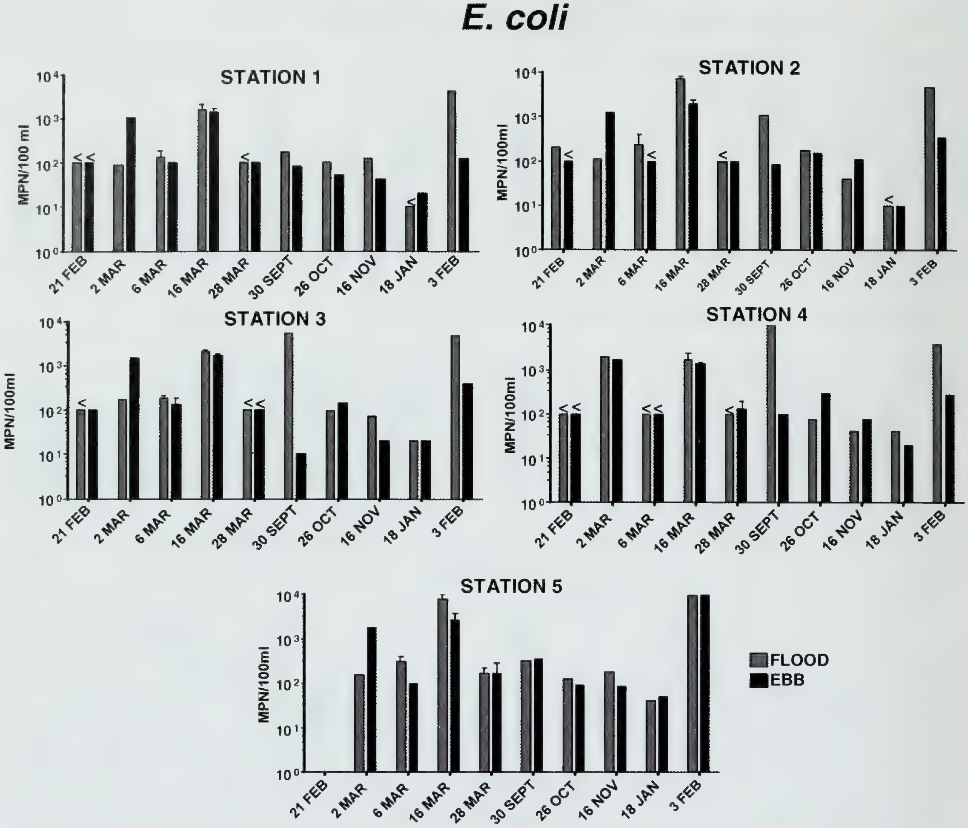

Fig. 3. Densities of *E. coli* (MPN/100 ml) during flood and ebb tidal flows, February 2003–2004. The "less than" symbol (<) indicates densities below the method detection level for the dilution used.

flows at all stations, ranging from 10^2 to 10^3 MPN/100 ml with the greater densities occurring during runoff events (Tables 3 and 4). However, the greatest density of this FIB group (41,060 MPN/100 ml) was measured at Station 4 on September 30, 2003 during dry weather. When looking at individual station histograms for *E. coli* (Fig. 3), flood densities exceeded ebb densities more than 50% of the time (Table 5) with the greatest percentages (80%) at Stations 1–3.

Enterococci. Mean Enterococci densities (Table 3) were slightly greater than those of *E. coli,* ranging from 10^3 to 10^4; the greatest density occurred during wet weather at Station 4 on March 16, 2003, where the count was measured at 141,360 MPN/100 ml. During dry weather, enterococci densities in flood flows tended to be greater on average than ebb flows, but this trend was not statistically significant (Table 3). Tests among replicated events did show a significant increase in Enterococci during the ebb flow at Station 2 during the March 16th wet weather event (Table 4). When individual stations histograms are examined, flood densities exceeded ebb densities greater than 50% of the time at all stations (Table 5).

Discussion

The central question in this study is whether or not the Ballona Wetlands act as a sink or source for FIB groups of bacteria. If acting as a sink, densities of

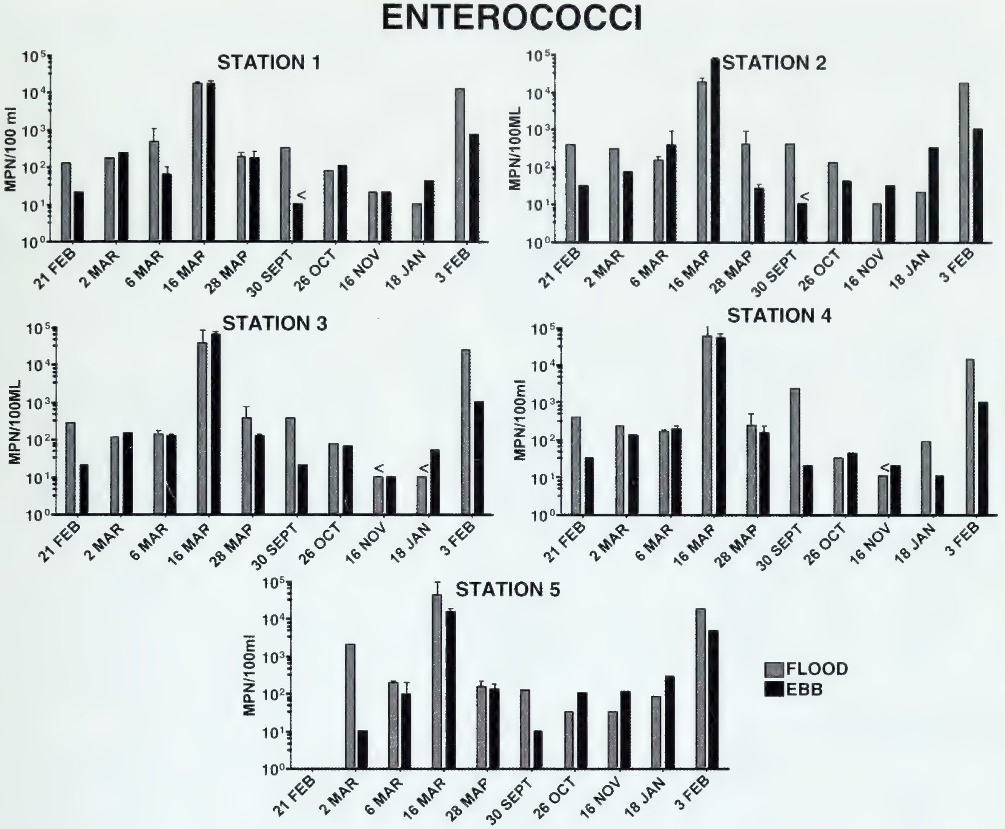

Fig. 4. Densities of Enterococci (MPN/100 ml) during flood and ebb tidal flows, February 2003–2004. The "less than" symbol (<) indicates densities below the method detection level for the dilution used.

FIB would be greater in flood tidal flows entering the marsh system from the Ballona Creek estuary. After entering the wetlands, FIB densities would be reduced through natural processes associated with sedimentation within vegetated areas (e.g. Wong and Geiger 1997, Dixon *et al.* 2003, Karathanasis *et al.* 2003) and deactivation by sunlight (e.g. Mayo 1995, Stinton 2002). Conversely, if the wetlands were acting as a source, then densities would be greater during ebb flows, and be most apparent in water out welling from the tidal gates into the Ballona Creek estuary. This situation has been found in Huntington Beach, California where enterococci out welling from the Talbert Marsh impacted adjacent coastal beaches (Grant *et al.* 2001). In Talbert Marsh, enterococci probably originated from bird feces and contaminated sediments suspended through tidal action.

Results presented herein suggest that the wetlands may act as a sink in that FIB densities tended to be greater during flood flows into the wetlands, but less in water draining out of the system during ebb flows. However, this condition was not consistently met, especially at stations farthest from the tide gates. These sites could be reflecting increased FIB densities through regrowth within sediments and other unidentified sources.

Tidal amplitudes appear to be linked to FIB densities during ebb flows as

Table 3. Mean densities (± 1 S.D.) of indicator bacteria (MPN/100 ml) at each station during flood and ebb tidal flows over the entire sampling period.

	Flood			
Sta	n	Mean	±SD	Range
Total Coliforms, Dry Weather:				
1	12	13,038	7,233	3,280–24,192
2	12	10,877	8,587	1,690–33,250
3	12	9,682	4,826	2,690–16,070
4	12	41,400	42,057	1,460–129,970
5	11	9,691	7,176	3,090–28,510
Total Coliforms, Wet Weather:				
1	4	703,955	353,353	241,920–980,400
2	4	480,705	167,677	241,920–613,100
3	4	628,780	263,431	241,920–816,400
4	4	717,555	335,020	241,920–980,400
5	4	340,205	91,354	241,920–461,100
E. coli, Dry Weather:				
1	12	107	46	10–200
2	12	222	299	10–1,112
3	12	567	1,547	20–5,475
4	12	3,646	11,794	10–41,060
5	11	206	107	41–410
E. coli, Wet Weather:				
1	4	2,254	1,271	1,210–4,106
2	4	6,716	1,424	4,884–8,010
3	4	2,718	1,264	1,990–4,611
4	4	2,201	1,068	1,340–3,654
5	4	8,429	2,084	5,370–9,804
Enterococci, Dry Weather:				
1	12	217	290	10–1,100
2	12	236	263	10–970
3	12	186	214	10–790
4	12	342	621	10–2,254
5	11	299	565	31–1,990
Enterococci, Wet Weather				
1	4	14,757	2,238	12,033–17,329
2	4	18,247	4,240	14,136–24,192
3	4	32,957	32,882	12,997–81,640
4	4	45,914	63,806	8,297–141,360
5	4	35,100	42,023	12,033–98,040

[1] Values of p were derived from a t-test using $\log_{10}$ transformed data and assuming equal variances; mean FIB densities tested between flood and ebb flows at each station during dry- and wet-weather periods.

evident from the FIB Flood:Ebb ratios (Fig. 6), and may be caused by bank washing during spring tides as hypothesized in Fig. 7. During neap tides the tidal range is relatively small, so little water washes the banks in the wetlands. Bacteria are carried into the system on the flood tides from Ballona Creek where they subsequently are reduced in numbers, probably from sunlight and other natural wetland process. Subsequently, densities are lower in the ebb tide flows. As the

Table 3. Extended.

Ebb					
n	Mean	±SD	Range	p^1	
12	6,548	2,669	1,490–10,462	0.007	*
11	13,423	6,308	2,770–24,192	0.130	NS
12	30,790	46,424	3,094–173,290	0.025	*
12	86,601	77,948	4,245–198,630	0.068	NS
11	4,188	3,463	960–12,033	0.005	*
4	731,066	589,950	10,462–1,413,600	0.280	NS
4	577,258	385,239	38,730–920,800	0.382	NS
4	503,128	317,977	46,110–770,100	0.245	NS
4	295,995	298,661	30,760-613,100	0.066	*
4	577,955	233,024	241,920–770,100	0.083	NS
12	163	282	20–1,053	0.494	NS
12	209	346	10–1,243	0.410	NS
12	202	392	10–1,434	0.165	NS
12	242	441	20–1,625	0.363	NS
11	292	515	52–1,816	0.320	NS
4	1,078	674	12–1,610	0.093	NS
4	1,631	894	354–2,400	0.006	*
4	1,340	639	399–1,750	0.050	*
4	1,106	558	272–1,460	0.072	NS
4	6,350	7,360	1,990–17,329	0.118	NS
12	89	80	10–259	0.064	NS
12	141	265	10–940	0.050	*
12	84	50	10–152	0.210	NS
12	103	81	10–223	0.110	NS
11	107	83	10–272	0.082	NS
4	12,281	8,204	733–19,863	0.206	NS
4	56,136	37,421	1,014–81,640	0.379	NS
4	47,557	32,591	987–77,010	0.472	NS
4	39,766	28,176	933–62,940	0.374	NS
4	12,929	5,626	4,721-17,329	0.144	NS

tidal cycle shifts into spring tide conditions, the tidal range increases. During high tide, contaminated Ballona Creek water is able to flood some areas in the wetlands (see Fig. 7). When the tide turns and flows back out into Ballona Creek, sediment particles with attached FIB species can be resuspended, thus adding to the ebb flows. Recent investigations by Ferguson *et al.* (2005) showed that densities of enterococci were much greater in sediments impacted by contaminated runoff, indicating retention and regrowth. They pointed out that resuspension of these sediments into the overlying water column was of concern since the attached densities of enterococci could be sufficient to exceed bathing water standards.

Table 4. Results of t-tests between mean FIB densities during flood and ebb flows during sampling events where replicate ($n = 3$) samples were collected at each station. For testing, variances were assumed to be unequal; only significant results ($p \leq 0.05$) are presented in this table.

			Mean density (MPN/100 ml)		
Date	Sta	FIB Grp	Flood	Ebb	p
3/16/03	4	Totals	876,100	384,407	0.039
3/16/03	5	Totals	372,967	689,967	0.004
3/16/03	2	E. coli	7,327	2,057	0.001
3/16/03	3	E. coli	2,087	1,653	0.011
3/16/03	5	E. coli	7,970	2,690	0.017
3/16/03	2	Enterococci	18,552	74,510	0.001

Stronger tidal flows associated with spring tide conditions may resuspend sediments, thus adding to FIB concentrations in the water column. Steets and Holden (2003) considered hydraulic resuspension of FIB contaminated sediments to be an important component in a model they developed to predict out welling of fecal coliforms from a small coastal lagoon in Santa Barbara, California.

If this "bank washing" model is operating in the wetlands, then increased tidal flows through restoration actions could have mixed outcomes with regard to FIB densities. As the tidal flow is increased within the wetland system, the mud banks of the tidal channels could broaden, and more vegetative banks would be submerged during high tides. More extensive mud bank exposure to tidal flows could resuspend greater loads of sediments, thus FIB. Conversely, during daylight hours at higher tidal levels, greater quantities of water contaminated with FIB would be exposed to sterilizing UV light as it lies over the submerged bank, thus reducing FIB densities.

Ballona Creek may be a significant source of FIB entering the Ballona Wetlands. Densities of FIB groups in flood tide flows entering the wetlands at Station 1 were within the ranges measured by others in Ballona Creek. Stein and Tiefenthaler (2004) measured dry weather densities of total coliforms, *E. coli,* and enterococci along the entire 12.7 km length of Ballona Creek. Highest densities were measured at sites immediately upstream of the tidal prism, and at the head of the open channel where it daylights, with geometric mean densities (MPN/100 ml) ranging from 10^2–10^3 for *E. coli* and enterococci, and 10^4 for total coliforms. Along the lower reaches of Ballona Creek and the upper portions of the Estuary,

Table 5. Percent of sampling events ($n = 10$) where FIB densities during flood flows were $\geq$ ebb flows. Percentages based on histograms in Figures 2–4.

	FIB group		
Sta	Total coliforms	*E. coli*	Enterococci
1	90	80	70
2	40	80	60
3	50	80	60
4	50	70	70
5	70	60	60

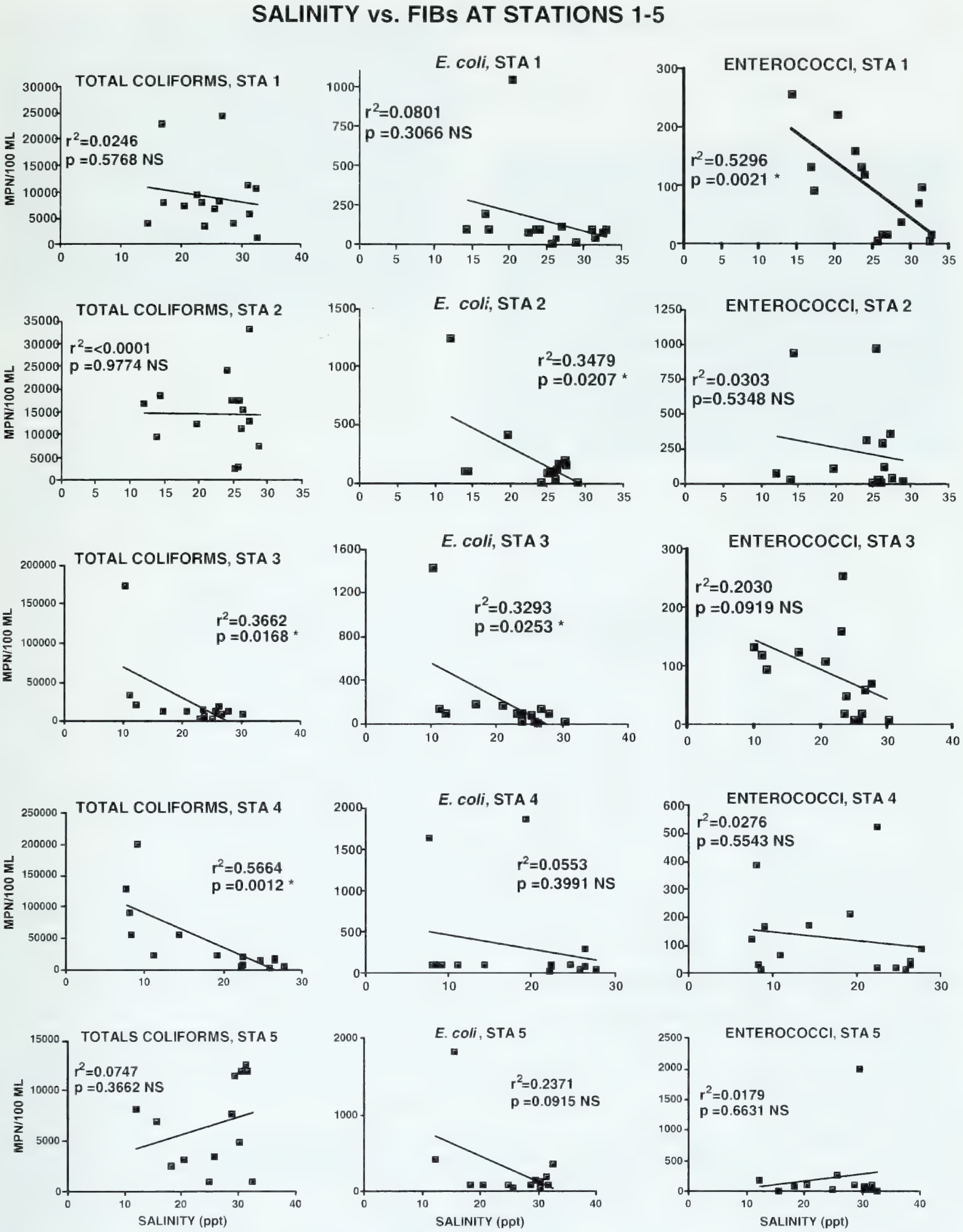

Fig. 5. Regression analyses of dry-weather salinity against each FIB group at Stations 1 through 4 in the wetlands, and Station 5 in Ballona Creek.

Dorsey and Lindaman (2004) measured similar FIB densities with total coliforms averaging 10^4–10^5 and *E. coli* and enterococci ranging from 10^2–10^3 MPN/100 ml.

During wet weather events, densities of the FIB groups in Ballona Creek increase several orders of magnitude as contaminated water enters the Creek system from storm drains throughout the watershed (Los Angeles County Department of Public Works 2002 and http://ladpw.org/wmd/NPDES/2001–02_report; Dorsey

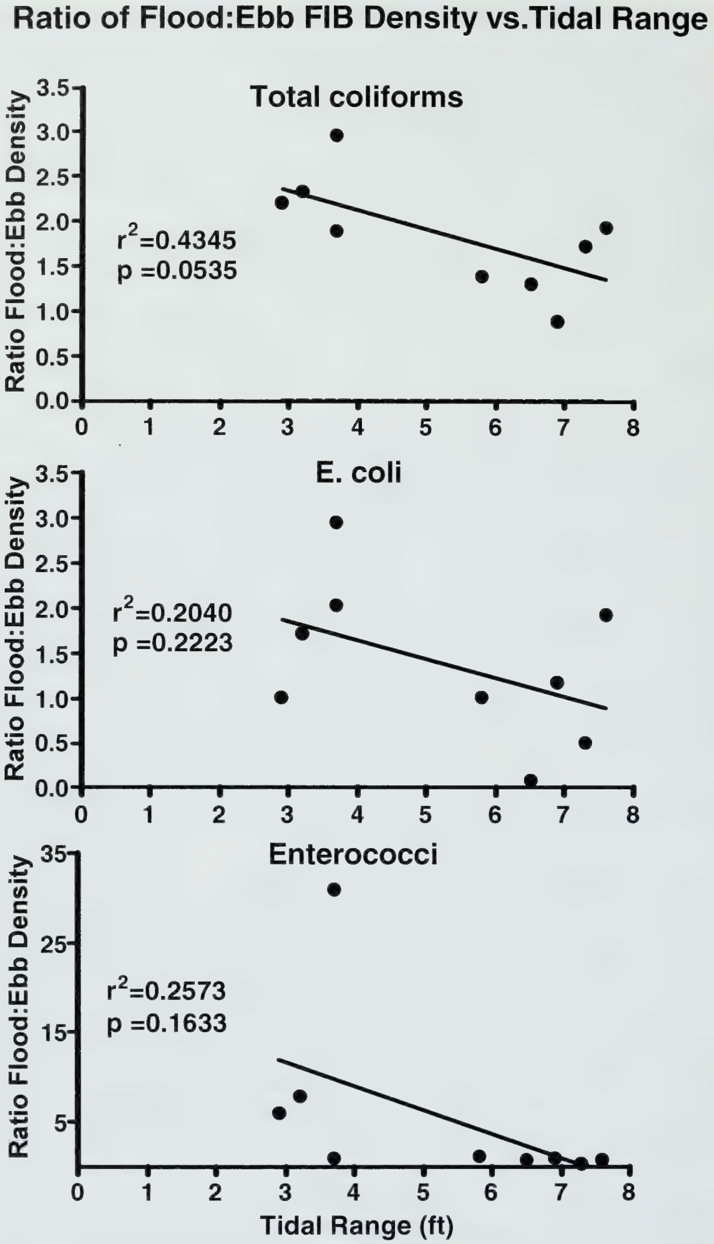

Fig. 6. Regression of tidal ranges versus the ratios of flood:ebb FIB densities for each indicator at Station 1, Ballona Wetlands. The wet-weather outlier from 2-3-04 was removed from the analyses.

and Lindaman 2004). Subsequently, this contaminated water enters the wetland system, lowering salinity to freshwater levels (Table 2) and increasing FIB densities by several orders of magnitude. Additional FIB sources would include bacteria attached to sediments carried by runoff from the salt marsh flats and the bluffs bordering the wetlands to the south.

Although data presented herein suggest that the wetlands may be acting as a

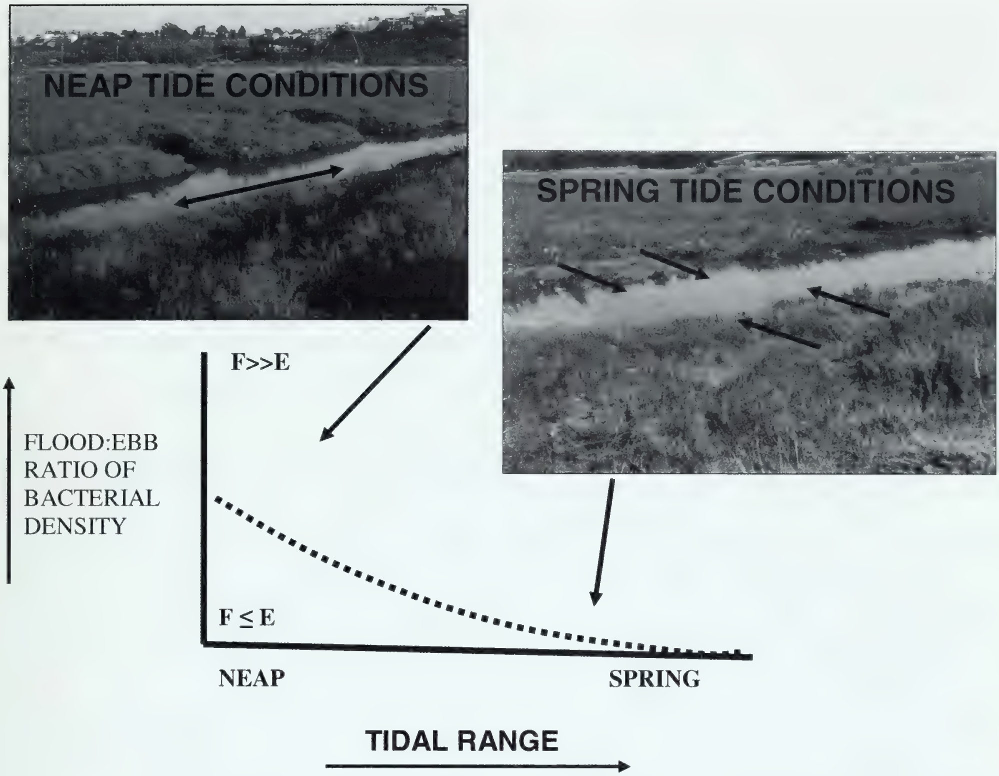

Fig. 7. Hypothesized bank-washing model (see text for explanation). Photographs are from Station 1 where the bank is covered with water during spring high tides.

sink for FIB, and that Ballona Creek may be a significant source for these bacteria, these premises were based on only 16 days of sampling at five stations over a one year period. Future studies need to focus on establishing overall hydrodynamics and tidal flushing of the wetlands, and determining mass balance of FIB entering and leaving this system during varying tidal cycles. Twenty-four hour studies employing frequent sampling will better determine the flux of FIB, especially during daylight hours when UV light can presumably reduce densities. More research is needed to determine the fate and transport of FIB within this system, retention and regrowth in wetland sediments, and purifying process within the tidal channels and on tidally submerged vegetation. As restoration actions are implemented, changes may occur in the dynamics of the wetland habitat and ecosystem conducive to water purification and FIB removal. At the same time, populations of vertebrates, especially birds, may significantly increase, thus increasing FIB densities. Therefore, we need to track these changing conditions and populations to better understand the consequences of restoration actions as this wetland returns to a more natural condition.

Acknowledgements

Kili Sueda (Loyola Marymount University), Sachiko Chyan (Marlborough High School) and Swati Yanadamala (Chadwick High School) played key roles in this study by helping with field and lab work. It was rewarding to work with these fine students; they were always enthusiastic, even at dawn during rainstorms. Many thanks to Ken Shiff (Southern California Coastal Water Research Project) for kindly reviewing the manuscript and offering excellent suggestions to improve its quality, and to the anonymous reviewers for their excellent recommendations. This work was supported through LMU Summer Research grants and funding from the LMU Department of Natural Science.

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Accepted for publication 13 February 2006.

Bull. Southern California Acad. Sci.
105(2), 2006, pp. 76–84

Interspecific Competition Between *Coleogyne ramosissima* Seedlings and *Bromus rubens*

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Abstract.—Interactive effects of red brome grass (*Bromus rubens*) density and time of establishment on the early survival and growth of blackbrush (*Coleogyne ramosissima*) seedlings were quantitatively investigated. Seeds of *Coleogyne* and *Bromus* were collected from Cold Creek of the Spring Mountains in southern Nevada. A series of pot trial experiments were conducted in a controlled environmental glasshouse. In mixed culture pots when *Coleogyne* seedlings planted four weeks later than *Bromus* at medium and high density levels, survival of *Coleogyne* seedlings (experimental populations) was greatly reduced compared to single *Coleogyne* seedlings that grew alone (control population). Significant interactions were detected between neighboring *Bromus* density and time of planting for shoot height, root/shoot ratio, leaf length, and shoot water potential of experimental *Coleogyne* populations. When *Bromus* density was examined independently, all measured growth parameters of experimental *Coleogyne* populations were significantly reduced compared to the control population. When time of planting was examined independently, shoot height, root/shoot ratio, shoot biomass, leaf length, and water potential of experimental *Coleogyne* populations were significantly reduced. Results of this study revealed that some *Coleogyne* mortalities occurred in the absence of interspecific competition, and that growth among surviving seedlings were significantly reduced under conditions of increased density of neighboring *Bromus* and early *Bromus* establishment.

Seed germination alone does not mean that a plant has become successfully established in a community. The seedling stage in plant life histories is the most vulnerable stage in development. During the developmental state, competition for space and resources does not occur between all plants in a population, but rather between the individual in question and the plants immediately surrounding the individual (Harper 1977; Antonovics and Levin 1980; Florentine and Fox 2003). Competition between plant species can be investigated directly by using pot trial experiments to minimize variation in all other factors that can independently and/or jointly affect survival and growth (Florentine and Fox 2003). Competition in plant communities implies that the supply of light, water, or nutrients to plants is diminished by the presence of neighbors and the proximity of plants to plants of either the same or different species (Harper 1977; Tilman 1982). The intensity of interspecific competition is highly dependent on the number of neighbors already present to capture the available space and resources (Florentine and Fox 2003). When plant density is high, individual plants can interfere with each other both aboveground and belowground (Mack and Harper 1977).

Interspecific competition occurs within shrublands between shrubs and grasses that differ in life history traits, including life cycles and growth patterns (Florentine and Fox 2003). In general, seedlings of woody species do not compete well with adjacent herbaceous species (Van Auken and Bush 1988). Grasses can use soil moisture and mineral nutrients faster than perennial shrubs (Jackson and Roy 1986). In mixed cultures of two species involving a woody and a herbaceous plant, the mean yield of woody species is heavily dependent on the relative density and percent cover of adjacent herbaceous species (Harper 1977; Florentine and Fox 2003).

Red brome grass (*Bromus rubens*) was introduced into the western United States during the mid-nineteenth century, but did not spread into the Mojave Desert until the early twentieth century (Hunter 1991). *Bromus* invaded springs, roadsides, and disturbed areas of the Mojave Desert during 1920's. It was not common, however, until after 1950 (Hunter 1991). *Bromus* is common in some locations around 4,000 to 5,000 feet in elevation at the Nevada Test Site (Hunter 1991). It is often a dominant herbaceous species found below 5,000 feet in *Coleogyne* and creosote bush-white bursage (*Larrea tridentata-Ambrosia dumosa*) shrublands of southern Nevada (Beatley 1966; Newman 1991). Competition for soil moisture from cheatgrass (*Bromus tectorum*), a closely related species to red brome grass, is a major cause in the reduction of *Coleogyne* seedling establishment at high and medium soil fertility levels under controlled laboratory conditions (Pendleton et al. 1999). Fertilization as a restoration technique may increase *Coleogyne* growth but, at the same time, can reduce survival and result in competitive exclusion of *Coleogyne* in the presence of *B. tectorum* (Pendleton et al. 1999).

Recruitment of *Coleogyne* is episodic in the Mojave Desert of southern Nevada. Growth activities in *Coleogyne* generally occur from March through mid-June when soil moisture is available in southern Utah (Bowns and West 1976) and southern Nevada (Lei and Walker 1997). Large numbers of *Bromus* also emerge around this period of time. By early to mid-June, *Bromus* have completed their entire life cycle, leaving abundant standing dead stems that persist for a year or two in the field (Hunter 1991; Newman 2001).

The survival and growth of newly emerged *Coleogyne* seedlings are variable in time and space under natural field conditions. If *Coleogyne* seeds germinate among dense carpets of *Bromus,* they may have a reduced chance of survival with a limited seedling growth due to competition effects compared to fewer, or no other, individuals of *Bromus* present. An understanding of the interspecific competition between *Coleogyne* and *Bromus* is critical to determine the cycle of seed germination, seedling establishment, and early mortality of *Coleogyne.* From casual observations, seedling densities and frequencies of *Coleogyne* are not high in natural fields. This phenomenon suggests that either *Coleogyne* seed production is very low, or that competition with other species for limited space and/or resources is high in southern Nevada.

This study investigated interspecific competition between *Coleogyne* seedlings and *Bromus* at different densities and times of planting under controlled environmental conditions using a series of pot trial experiments. Two hypotheses were made prior to data collection. First, the survival and growth of *Coleogyne* seedlings (experimental populations) were reduced with increasing *Bromus* density or early *Bromus* establishment (time of planting) relative to *Coleogyne* seedlings that grew alone (control population). Second, there were interactions between neighboring *Bromus* density and time of planting for many growth characteristics of *Coleogyne* seedlings.

Methods

Seed Collection Site

Seeds of *Coleogyne* and *Bromus* were collected at mid-elevations of a nearly monospecific *Coleogyne* shrubland in Cold Creek (36°25′N and 115°28′W; 1,250 to 1,405 m in elevation), located on the eastern slope of the Spring Mountains in southern Nevada. A total of 300 *Coleogyne* and 800 *Bromus* seeds, along with their corresponding field soils from the upper 10 cm, were collected in late July 2004. From casual observations, flattened, wrinkled, or empty (potentially inviable) seeds of both species were discarded in the field before transporting to a laboratory at Nevada State College (NSC).

Germination Experiments

After initial screenings, seeds were placed at room temperature (22°C) for storage. *Bromus* and *Coleogyne* seeds were placed in a cool chamber (dry chilled) at 4°C for two and six weeks without light, respectively, prior to the initiation of germination and pot trial experiments. Ungerminated seeds that were firm and turgid were recorded as potentially viable.

During the germination period, 20 seeds of the same species were placed between two layers of filter papers moistened with tap water inside a 10-cm diameter Petri dish. Stacks of Petri dishes were placed in transparent plastic bags in the cool chamber to decrease evaporative water loss, and water was added as necessary to maintain saturation of filter papers during incubation. *Coleogyne* seeds were incubated at 4°C, while *Bromus* seeds were incubated at 22°C in the dark except for an occasional, brief exposure to fluorescent lights. Radicle emergence $\geq$ 1 mm was the criterion for seed germination (Lei 1997). Germination occurred between 2–3 weeks at a 87% rate for *Coleogyne,* and occurred within two weeks at a 90% rate for *Bromus.*

Pot Trial Experiments

Transplanting commenced on November 14, 2004 for the early germinating *Bromus* and completed on January 9, 2005 for the later *Bromus* in the glasshouse. All other seedlings were introduced into pots on December 12. *Bromus* was selected because it has often coexisted with *Coleogyne* as a common herbaceous species at mid-elevations of southern Nevada. Three densities of *Bromus*: low, medium, and high were represented by two, four, and six individual plants, respectively, with a single *Coleogyne* seedling.

Five-week old *Coleogyne* and three-week old *Bromus* seedlings were transplanted into small, cone-shaped containers (plastic pots) that were 6.5 cm in diameter and 35 cm tall. Pots were placed in a glasshouse at the Henderson Campus of Community College of Southern Nevada (CCSN) from mid-November 2004 through early June 2005. Each pot contained one-third perlite and two-thirds natural field soil, without adding fertilizers in order to maintain a low soil fertility level. Perlite was used to improve aeration and drainage (Lei 2004).

Plantings of *Coleogyne* and *Bromus* were made on three different dates. The first planting date was on the "same day" when both *Coleogyne* and *Bromus* were introduced into pots simultaneously on December 12, 2004. The second planting date was "early grass", in which *Bromus* was initially introduced into pots on December 12, and 28 days later *Coleogyne* was introduced (January 9, 2005). The third date was "late grass', in which *Coleogyne* was planted first on November 14, 2004, and the *Bromus* was planted later on December 12. *Coleogyne* was planted first in order to promote seedling survival and growth. *Coleogyne* seedlings were placed in the center of each pot, while individuals of *Bromus* were placed on the periphery. All 15 replicates of each treatment received the same amount of irrigation and liquid fungicide, as well as the same intensity of incoming sunlight (experimental populations). Single *Coleogyne* seedlings without the presence of *Bromus* were served as a control population, and were used to compare with various density levels and times of planting (experimental populations).

Prior to planting, care was taken to allocate seedlings by size to various experimental treatments, so that no single treatment had disproportionally large or small seedlings. Pots were lightly moistened with tap water for 20 weeks (five months) in the glasshouse. Initially, seedlings were watered twice a week for the first three weeks, and thereafter once a week until the end of pot trial experiments. A small amount of liquid fungicide was applied monthly. Any deaths observed during the first few days were immediately replaced with new *Coleogyne* seedlings. A mortality rate in each experimental treatment was recorded.

Water status of each *Coleogyne* seedling was determined using a portable pressure chamber (Plant Moisture Stress Instrument Company; Covallis, OR) as described by Scholander et al. (1965) in order to quantify the soil water environment encountered by the root system. The chamber was pressurized with nitrogen gas. Once the shoots were incised, water potential measurements were made immediately in the glasshouse to decrease evaporation loss. Shoots were sealed into the chamber, and the pressure indicated at the first sign of water at the cut end was recorded as an estimate of shoot water potential (Lei 2004).

All surviving *Coleogyne* seedlings were harvested five months after planting by carefully removing them from pots, and soil was gently rinsed away with slow-flowing tap water. Intertwined roots of *Bromus* and *Coleogyne* were carefully separated while their roots were submerged in water. *Coleogyne* were separated into root and shoot components. Root length, shoot length, and basal shoot diameter were measured with a metric ruler. Root and shoot biomass were obtained after oven-drying at 65°C for 36 hours.

Statistical Analyses

Germination was computed on the basis of percentages of potentially viable seeds. Mortalities of *Coleogyne* seedlings with respect to neighboring *Bromus* density and time of planting were expressed with percentages. A two-way Analysis of Variance (ANOVA; Analytical Software 1994) was conducted to detect significant differences in shoot height, root/shoot ratio, basal shoot diameter, root and shoot biomass, leaf length, and shoot water potential (growth characteristics) of *Coleogyne* seedlings, with neighboring *Bromus* density and time of planting

Table 1. Mortality and harvest values (mean ± SE, n = 15 per density level per growth characteristic) of *Coleogyne* seedlings grown in mixed cultures with *Bromus* when Bromus individuals were planted four weeks earlier. Low, medium, and high densities represent two, four, and six individuals of *Bromus* per pot, respectively. Statistical comparisons and significance are indicated in Table 4.

	Number of *Bromus* individuals per pot			
Growth variable	Control	2	4	6
Mortality (%)	13.3	26.7	46.7	53.3
Shoot height (cm)	6.7 ± 1.2	5.7 ± 1.3	4.4 ± 1.1	3.8 ± 1.2
Root/shoot ratio	1.9 ± 0.1	2.2 ± 0.2	2.4 ± 0.2	2.6 ± 0.1
Shoot diameter (mm)	3.6 ± 0.2	2.8 ± 0.2	2.4 ± 0.1	2.0 ± 0.1
Shoot biomass (g)	0.17 ± 0.05	0.15 ± 0.06	0.11 ± 0.05	0.09 ± 0.04
Root biomass (g)	0.04 ± 0.01	0.05 ± 0.01	0.07 ± 0.01	0.09 ± 0.01
Leaf length (mm)	6.2 ± 0.8	5.8 ± 0.7	5.3 ± 0.6	4.8 ± 0.5
Water potential (MPa)	−1.7 ± 0.1	−2.3 ± 0.2	−2.7 ± 0.1	−3.1 ± 0.2

as main effects. Mean values were presented with standard errors, and statistical significance was determined at $p \leq 0.05$ level.

Results

Low mortality was observed when *Coleogyne* seedlings grew alone in the absence of interspecific competition (13.3%; Table 1). Highest mortality was found (53.3%) when individuals of *Bromus* were established four weeks before *Coleogyne* in high density than in low density of control pots (Table 1). All *Coleogyne* growth parameters with medium *Bromus* density had intermediate values (Table 2) between high and low densities (Tables 1 and 3, respectively). When *Coleogyne* was planted four weeks before *Bromus,* substantial deaths still occurred at the high density level (26.7%; Table 3).

Density of neighboring *Bromus* had a significant effect on growth of experimental *Coleogyne* populations irrespective of establishment time. High *Bromus* density significantly increased root/shoot ratio, but decreased shoot height, basal shoot diameter, root and shoot biomass, leaf length, and shoot water potential of experimental populations compared to the control population ($p \leq 0.05$; Table 4).

Table 2. Mortality and harvest values (mean ± SE, n = 15 per density level per growth characteristic) of *Coleogyne* seedlings grown in mixed cultures with *Bromus* when both species were planted simultaneously. Low, medium, and high densities represent two, four, and six individuals of *Bromus* per pot, respectively. Statistical comparisons and significance are indicated in Table 4.

	Number of *Bromus* individuals per pot			
Growth variable	Control	2	4	6
Mortality (%)	13.3	20.0	33.3	40.0
Shoot height (cm)	6.7 ± 1.2	6.1 ± 1.3	5.5 ± 1.1	5.0 ± 1.2
Root/shoot ratio	1.9 ± 0.1	2.1 ± 0.2	2.5 ± 0.2	2.7 ± 0.1
Shoot diameter (mm)	3.6 ± 0.2	3.1 ± 0.2	2.7 ± 0.1	2.3 ± 0.2
Shoot biomass (g)	0.17 ± 0.05	0.15 ± 0.04	0.13 ± 0.03	0.11 ± 0.02
Root biomass (g)	0.04 ± 0.01	0.05 ± 0.01	0.07 ± 0.01	0.08 ± 0.02
Leaf length (mm)	6.2 ± 0.8	5.9 ± 0.7	5.6 ± 0.6	5.0 ± 0.5
Water potential (MPa)	−1.7 ± 0.1	−2.2 ± 0.2	−2.5 ± 0.1	−2.8 ± 0.2

Table 3. Mortality and harvest values (mean ± SE, n = 15 per density level per growth characteristic) of *Coleogyne* seedlings grown in mixed cultures with *Bromus* when *Coleogyne* individuals were planted four weeks earlier. Low, medium, and high densities represent two, four, and six individuals of *Bromus* per pot, respectively. Statistical comparisons and significance are indicated in Table 4.

	Number of *Bromus* individuals per pot			
Growth variable	Control	2	4	6
Mortality (%)	13.3	20.0	20.0	26.7
Shoot height (cm)	6.7 ± 1.2	6.4 ± 1.3	6.0 ± 1.3	5.7 ± 1.2
Root/shoot ratio	1.9 ± 0.1	2.0 ± 0.2	2.2 ± 0.2	2.4 ± 0.1
Shoot diameter (mm)	3.6 ± 0.2	3.3 ± 0.2	2.9 ± 0.1	2.7 ± 0.2
Shoot biomass (g)	0.17 ± 0.05	0.16 ± 0.06	0.15 ± 0.05	0.13 ± 0.04
Root biomass (g)	0.04 ± 0.01	0.05 ± 0.01	0.06 ± 0.01	0.07 ± 0.01
Leaf length (mm)	6.2 ± 0.8	6.0 ± 0.7	5.8 ± 0.6	5.5 ± 0.5
Water potential (MPa)	−1.7 ± 0.1	−1.9 ± 0.2	−2.1 ± 0.1	−2.3 ± 0.2

Time of planting also had a significant effect on certain growth parameters of experimental *Coloegyne* seedlings irrespective of neighboring *Bromus* density. Early *Bromus* establishment significantly reduced shoot height, shoot biomass, leaf length, and water potential, but increased root/shoot ratio of *Coleogyne* seedlings compared to *Bromus* established four weeks after *Coleogyne* ($p \leq 0.05$; Table 4). Nevertheless, basal shoot diameter, as well as root and shoot biomass of did not differ significantly between control and experimental populations, with respect to time of planting ($p > 0.05$; Table 4).

Growth of *Coleogyne* seedlings was significantly affected by interactive effects of neighboring *Bromus* density and time of establishment. A two-way ANOVA revealed that neighboring *Bromus* density * time of planting interaction was statistically significant for shoot height, root/shoot ratio, leaf length, and shoot water potential of *Coleogyne* seedlings ($p \leq 0.05$; Table 4). A combination of high *Bromus* density and early *Bromus* emergence significantly decreased these four growth parameters of experimental seedlings ($p \leq 0.05$; Table 4). However, the *Bromus* density * time of time was not statistically significant for basal shoot diameter, as well as root and shoot biomass of *Coleogyne* seedlings ($p > 0.05$; Table 4).

Table 4. Summary of two-way ANOVA showing effects of neighboring *Bromus* density, time of planting, and their interactions on various growth characteristics of *Coleogyne* seedlings. Statistical significance was determined at $p \leq 0.05$. df = 2 for time of planting, df = 3 for neighboring *Bromus* density, and df = 6 for *Bromus* density and time of planting combination.

	Bromus density		Time of planting		Density * time	
Variable	F	P	F	P	F	P
Shoot height	198.65	<0.0001	72.95	<0.0001	14.39	0.0001
Root/shoot ratio	173.44	<0.0001	27.00	0.0001	5.22	0.0090
Shoot diameter	21.78	0.0006	1.78	0.2297	0.44	0.7740
Shoot biomass	68.40	<0.0001	14.93	0.0007	2.15	0.1285
Root biomass	17.68	0.0002	2.00	0.1810	1.64	0.2247
Leaf length	102.45	<0.0001	13.94	0.0010	5.63	0.0068
Water potential	101.17	<0.0001	42.51	<0.0001	3.53	0.0337

Discussion

This study demonstrated that some *Coleogyne* mortalities occurred in the absence of interspecific competition, but that early emergence of *Bromus* at the high density level significantly reduced the performance of experimental *Coleogyne* seedlings compared to control seedlings. Due to different life history strategies, experimental *Coleogyne* populations experienced major disadvantages in competing for space and moisture when planting simultaneously with *Bromus* seedlings, or when planted four weeks after *Bromus* establishment.

In this study, *Bromus* at high density was shown to have early, adverse impact on various growth parameters of experimental *Coleogyne* seedling populations, including increased root/shoot ratio, and decreased shoot growth and water potential values. Increased mortality and decreased growth among experimental populations were indications of water stress, as evidenced by significantly lower (more negative) shoot water potential values under local crowding compared to the control population.

Time of planting also played a major role in early *Coleogyne* mortality and reduced growth of experimental seedling populations. Among the three periods of planting, mortality of experimental *Coleogyne* seedlings was highest when established four weeks after *Bromus.* The species that germinates first is likely to have a competitive advantage (Florentine and Fox 2003). In this study, *Coleogyne* must become established at least four weeks prior to the emergence of Bromus in order to gain a competitive advantage. Earlier establishment of *Coleogyne* seedlings than the competing *Bromus* suggested that early germination of *Coleogyne* would enhance seedling survival and subsequent growth, primarily through a more rapid development of root biomass. For this reason, early germinants would be superior competitors relative to later germinants (Fowler 1986; Florentine and Fox 2003).

One reason for the observed reduction of *Coleogyne* shoot growth in the presence of *B. tectorum* may be found in the biomass allocation patterns (Pendleton et al. 1999). Interspecific competition resulted in an altered allocation pattern for *Coleogyne* (Pendleton et al. 1999). In mixture with *Bromus, Coleogyne* root length and root/shoot ratio increased when grown with *Bromus* in this study. In the absence of competition from *Bromus,* root/shoot ratio of *Coleogyne* was reduced. However, when competition was introduced, the root/shoot ratio of *Coleogyne* actually increased (Pendleton et al. 1999), which is in agreement with this study. Therefore, root competition in the very early stages of seedling growth would be an important factor contributing to the death of *Coleogyne* seedlings (Lei 2004).

The timing of germination in *Coleogyne* varies in time and space, depending on the seasonal moisture availability. Under field conditions where soil moisture is sufficient for seedling recruitment of *Coleogyne, Bromus* is also stimulated (Lei, personal observation). Consequently, newly emerged *Coleogyne* seedlings are often concealed among dense carpets of *Bromus* and other herbaceous plant species. Early emergence would give *Coleogyne* seedlings the best possible opportunity to gain more control of available space and resources compared to establishment of *Bromus* four weeks after, or at the same time as, *Coleogyne* seedlings. Availability of soil moisture, along with early seed germination at least four weeks prior to *Bromus* emergence would be two ideal conditions for *Coleogyne* seedlings to establish and survive with low mortality rates.

This pot trial study demonstrated that interactive effects of *Bromus* density and time of planting significantly, reduce the early survival and growth of experimental *Coleogyne* seedlings. A combination of increasing neighboring *Bromus* density and early *Bromus* emergence resulted in a direct reduction in the survival and growth of *Coleogyne* seedlings. Competition is ubiquitous, and can be examined directly in both monocultures and mixed cultures. This study also revealed that single seedlings of *Coleogyne* that grew alone had the lowest mortality rate, grew significantly better, and produced more biomass than *Coleogyne* seedlings that were locally crowded and/or established four weeks after *Bromus* emergence. However, the *Bromus* density * time of planting interaction was not statistically significant for basal shoot diameter, as well as root and shoot biomass of *Coleogyne* seedlings, indicating that both high density and early emergence of *Bromus* had a similar adverse effect on biomass and shoot diameter of early *Coleogyne* seedling populations.

Ecological Implications

In this pot trial study, early mortality and limited growth reflect the poor competitive ability of *Coleogyne* seedlings in the natural field. Attempting to revegetate *Coleogyne* in natural habitats has a limited success. Two contributing factors are competition with invasive, ruderal (exotic) species and the extremely slow growth of *Coleogyne* (Pendleton et al. 1999). Because of different life history strategies, *Coleogyne* seedlings generally did not compete well with species of *Bromus.*

Although a common reclamation practice, fertilization may place slow-growing *Coleogyne* at a competitive disadvantage (Pendleton et al. 1999). Laboratory studies also demonstrate that *Coleogyne* seedlings exhibited reduced survivorship and competitive ability when grown in competition with neighboring *B. tectorum* under high level of fertilization. The rapid growth of *B. tectorum* in response to fertilization shaded out the slow-growing *Coleogyne,* resulting in stunted growth or death of *Coleogyne* (Pendleton et al. 1999). For these reasons, early seed germination and seedling establishment of *Coleogyne* at least four weeks prior to the emergence of *Bromus* and other ruderal species at low soil fertility would be ideal conditions for them to establish and survive.

Finally, one must realize that *Coleogyne* seedlings grown in mixed cultures were at densities lower than those normally encountered in field situations. Extrapolating from controlled experimental results to field conditions should be done with caution because there are many biotic and abiotic factors interacting with each other, and because there are multiple limiting factors in the field (Florentine and Fox 2003; Lei 2004). During the period of growth associated with establishment, competition for limited space and resources (water, nutrients, and light) may intensify as individual plants develop (Florentine and Fox 2003). Although *Coleogyne* are at a competitive disadvantage in disturbed sites dominated by ruderal vegetation, long-term field and laboratory research studies are required to determine exactly which resources these *Coleogyne* and *Bromus* are competing for. This study, however, is an attempt to mimic natural field conditions, and to understand how newly recruited *Coleogyne* seedlings compete with various cohorts of *Bromus,* with respect to neighboring density and time of planting.

Acknowledgments

I gratefully acknowledge Steven Lei, David Valenzuela, and Shevaun Valenzuela for collecting *Coleogyne* and *Bromus* seeds and corresponding soils in the field. Steven Lei assisted with statistical analysis. Stephen Ferris provided helpful comments on earlier versions of this manuscript. The Biology Departments at Community College of Southern Nevada (CCSN) and Nevada State College (NSC) provided logistical support.

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Accepted for publication 3 February 2006.

Bull. Southern California Acad. Sci.
105(2), 2006, pp. 85–90

Research Notes

A Miocene Chimaeroid Fin Spine from Kern County, California

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Chimaeroids are cartilaginous marine fishes with continuously growing tooth plates in the upper and lower jaws, and have long been regarded as an obscure lineage (Didier 1995). They first appear in the fossil record in the Early Jurassic (Ward and Duffin 1989; Stahl 1999) and reached a peak of diversity during the Mesozoic. The group dwindled during the Cenozoic and survive today in only six extant genera assigned to three families (Didier 1995). Fossil chimaeroids are typically preserved as isolated dental plates, dorsal fin spines, and very rarely as complete specimens. In the absence of skeletal elements, chimaeroid species are diagnosed on the characteristics of dental plates. Dorsal fin spines are not diagnostic to species when they are not directly associated with dental or skeletal elements. There is little specific variation in size, length, or ornamentation of fin spines (Case and Herman 1973).

A well-preserved dorsal fin spine of the extinct chimaeroid genus *Edaphodon* Buckland 1838, was recovered from the upper Olcese Sand (late Early Miocene) of California, and is the geochronologically youngest reported occurrence of *Edaphodon* from the fossil record of North America. The fin spine, Natural History Museum of Los Angeles County (LACM) 40211, was collected from the Barker's Ranch area in the southeastern San Joaquin Basin, approximately 13 km northeast of Bakersfield, Kern County, California, and north of the Kern River. The beds in this area contain a gastropod-rich molluscan fauna (the Barker's Ranch Fauna) that serves as a standard of reference for the Miocene provisional mega-invertebrate "Temblor Stage" of Addicott (1972). The locality, LACM locality 6602, is in one of several north-south trending canyons in the NW $^1/_4$ of Sec. 33, T. 28 S., R. 29 E., Rio Bravo Quadrangle, 7.5 Minute Series (U.S. Geological Survey topographic map). A late Early Miocene age (ca. 16–18 Ma) for this horizon is based on molluscan biochronology (Addicott 1970), biostratigraphic correlation (Savage and Barnes 1972), benthic foraminiferal biostratigraphy (Olson 1990), and strontium isotope data (Olson 1988). The published strontium isotope dates of Olson (1988) yield a mean age of 16.7 Ma near the top of the upper Olcese Sand and are compatible with benthic foraminifera, which suggest an upper Relizian age.

There is some uncertainty surrounding the exact stratigraphic provenance of LACM locality 6602. Clarke and Fitch (1979:492) placed the locality in the "upper part of the Olcese Sand." However, Barnes and Mitchell (1984:17) referred the locality to the "lower part of the Round Mountain Silt, below the Sharktooth

Hill bone bed." Neither provided accurate stratigraphic nor locality data. In the Barker's Ranch area, the upper Olcese Sand is composed of fossiliferous very fine to fine-grained, marine sandstone to sandy siltstone, with interbeds of transported shells, whereas the lowermost Round Mountain Silt is a mottled siltstone (Olson 1990). The specimen was found in a shell bed directly below a calcareously cemented sandstone that is approximately 14 m stratigraphically below a mottled siltstone. The *Edaphodon* specimen described herein is considered to be from sediments of the upper Olcese Sand.

In the 1960's, the late John E. Fitch lead numerous collecting trips to the Barker's Ranch area, and over a period of several years removed and processed nearly 1,800 kg of fossiliferous matrix from the upper Olcese Sand. This material has produced, in addition to LACM 40211, more than 100,000 teleostean otoliths (saccular), which represent as many as 65 species belonging to 30 or more families, several thousand teeth of sharks, skates, and rays, *Cetorhinus* (basking shark) gill rakers, and hundreds of squid statoliths (Clarke and Fitch 1979). Abundant otoliths of sciaenids (drums and croakers), pleuronectids and bothids (right- and left-eyed flatfishes), serranids (basses), atherinids (silversides), mugilids (mullets), clupeids (herrings), and several other families that suggest a nearshore environment, are also present. Otoliths of deepwater forms such as morids (morid cods), melamphaids (bigscale fishes), and myctophids (lanternfishes) are relatively rare.

Systematic Paleontology

Class Chondrichthyes Huxley, 1880
Subclass Subterbranchialia Zangerl, 1979
Superorder Holocephali Bonaparte, 1832
Order Chimaeriformes Obruchev, 1953
Suborder Chimaeroidei Patterson, 1965
Family Callohynchidae Garman, 1901
Subfamily Edaphodontinae Stahl, 1999
Genus *Edaphodon* Buckland, 1838
Edaphodon sp.
Figs. 1–2

Material.—LACM 40211, incomplete distal end of dorsal fin spine, collected by one of the authors (RWH) in 1969 from LACM locality 6602, Barker's Ranch, Kern County, California.

Description.—Partial dorsal fin spine (Fig. 1), measuring 115 mm in preserved length, with undetermined amount of basal portion missing. Laterally compressed, subovate in cross-section, and only slightly curved posteriorly, with faint longitudinal striations on lateral faces. Anterior margin with sharp keel; posterior margin with double row of small, evenly spaced, ventrally curved denticles, separated from each other by a shallow median groove extending for nearly the entire preserved length. In cross-section (Fig. 2), anterior area of spine consists of a thick layer of trabecular tissue with vascular canals; a thin layer of trabecular tissue with vascular canals present on posterior and posterolateral area; a thin layer of lamellar tissue lacking vascular canals present on lateral area of spine; and large subovate pulp cavity present in central region of spine.

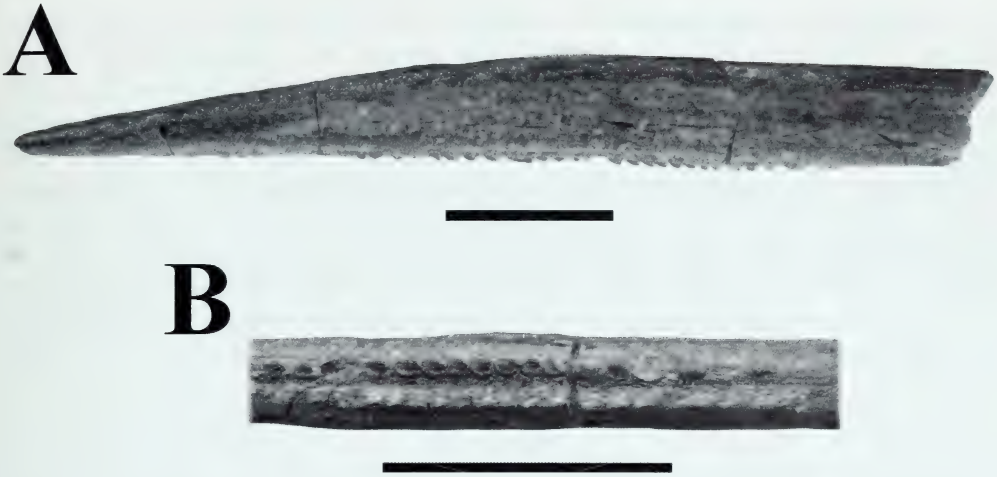

Fig. 1. Incomplete dorsal fin spine of *Edaphodon* sp., LACM 40211. **A.** right lateral view; **B.** posterior view. Scale bars equal 2 cm.

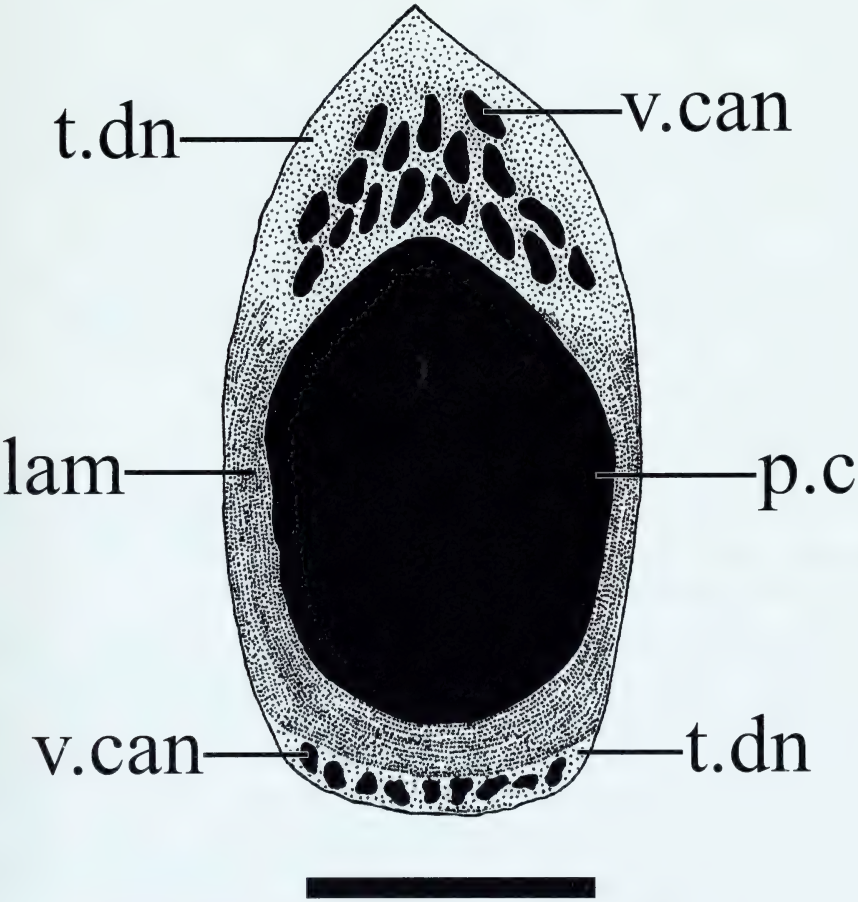

Fig. 2. Cross-section drawing of dorsal fin spine of *Edaphodon* sp., LACM 40211. Scale bar equals 0.5 cm. **Abbreviations**: **lam**, lamellar tissue; **p.c**, pulp cavity; **t.dn**, trabecular tissue; **v.can**, vascular canals.

Comparisons.—LACM 40211 is referable to the extinct chimaeroid genus *Edaphodon.* Assignment of this specimen to a species is unwise based upon such limited material. The dorsal fin spine of *Edaphodon* closely resembles that of the extinct genus *Ischyodus* Egerton 1843, but differs from the latter genus by displaying a weakly compressed subovate fin spine with a large subovate pulp cavity, and an incomplete trabecular tissue layer confined to the anterior and posterior spine edge. The fin spine of *Ischyodus,* in contrast, is strongly compressed laterally, with a narrow rectangular pulp cavity, and the trabecular tissue layer completely surrounds the outer margin of the spine. For description and figure for the fin spine of *Ischyodus* compare also Patterson (1965:113, fig. 4). In recent chimaeroids, the trabecular tissue is restricted to the anterior edge of the spine (Stahl 1999).

Discussion

Edaphodon is known only from tooth plates and fragments of dorsal fin spines, from Early Cretaceous to Pliocene age deposits of Europe, North America, Australia, and Africa (Stahl 1999). In North America, the genus is largely known from Maastrichtian age deposits, and they survived the biotic stresses of Late Cretaceous time to persist into the early part of the Cenozoic. The callorhynchids were thought to have disappeared from the Northern Hemisphere at the end of the Eocene, and persisted in Southern Hemisphere seas throughout the Tertiary (Stahl and Chatterjee 2002). The *Edaphodon* specimen described herein extends the range of the genus in North America to the Early Miocene, and represents the first occurrence of the genus around the eastern north Pacific Rim. This is only the second description of a fossil chimaeroid from California, and reported occurrences of chimaeroids from western North America are very rare. Applegate (1975) described *Ischyodus zinsmeisteri,* a mandibular tooth plate of Paleocene age, from Simi Hills, Ventura County, California. Ward and Grande (1991) regarded features used by Applegate (1975) as ontogenetic, and they considered *I. zinsmeisteri* as a junior synonym of *I. dolloi* Leriche 1902.

Dorsal fin spines generally referred to *Edaphodon* have been typically described as gently arched, slightly compressed, and smooth-walled, except for fine parallel longitudinal striations with a row of denticles along each of its two posterolateral edges, but none along the anterior keel. Duffin and Reynders (1995) reported a complete fin spine referable to *Edaphodon* with a single row of anterior denticles as well as the posterolateral rows. Stahl and Parris (2004) reported fragmentary distal ends of two fin spines associated with a complete dentition of *E. mirificus* Leidy 1856, showing a series of minute enameloid-covered structures on the anterior keel that closely resemble the denticles that Duffin and Reynders (1995) reported. However, on neither of the fin spine fragments was the series of anterior denticles complete. In LACM 40211, denticles are absent from the anterior margin of the preserved half, and it is likely that, as in many chimaeroid fin spines referred to *Edaphodon,* denticles are absent proximally from both the anterior and posterolateral margins. We believe that LACM 40211 is referable to this genus, and further study to determine the significance of the variant patterns of denticle development is required.

Stahl (1999) noted that fossil chimaeroid remains are found in shallow water environments, but it is not certain these fishes actually inhabited such environments. Extant chimaeroids inhabit deepwaters, with some species being known to venture into shallower areas offshore to feed, or even to come nearshore to breed (Bigelow and Schroeder 1953). Obruchev (1967) reported egg cases, but no skeletal remains, of chimaeroids in Mesozoic shallow marine deposits; he believed the egg cases were deposited by species of deepwater chimaeroids that are presently unknown from the fossil record. It is possible that *Edaphodon,* like extant chimaeroids, normally inhabited moderately deepwater environments, but occasionally ventured into the shallows, and this may explain why after extensive sampling only a single chimaeroid specimen has been recovered from the upper Olcese Sand.

Acknowledgments

The late J. E. Fitch first found the locality, initiated excavation, and assisted one of the authors (RWH) in collection of the specimen described in this paper. Comments by L. G. Barnes and C. A. Shaw, and reviews by Kenshu Shimada and two anonymous reviewers greatly improved the clarity of this paper. Many thanks also to S. A. McLeod and J. D. Stewart for access to the collections.

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Accepted for publication 27 September 2005.

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CONTENTS

A Mid-Holocene Fauna from Bear Den Cave, Sequoia National Park, California. Jim I. Mead, Thomas W. McGinnis, and Jon E. Keeley 43

Densities of Fecal Indicator Bacteria in Tidal Waters of the Ballona Wetlands, Los Angeles County, California. John H. Dorsey 59

Interspecific Competition Between *Coleogyne ramosissima* Seedlings and *Bromus rubens*. Simon A. Lei. 76

A Miocene Chimaeroid Fin Spine from Kern County, California. Gary T. Takeuchi and Richard W. Huddleston. 85

Cover: Salamander trunk vertebrae from Bear Den Cave. Photos by Sandra L Swift.

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Volume 105 **Supplement to Southern Academy of Sciences Bulletin Number 2**

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Molecular Biology and Physiology: Kurt W. Karageorge. Dept. of Biological Sciences, California State University, Long Beach. Advisor. Dr. Raymond Wilson
MICROSATELLITE DNA ASSESSMENT OF MULTIPLE PATERNITY IN THE VIVIPAROUS ROCKFISH *SEBASTES MELANOPS*

Physical Sciences: Suzanne M. Baltzer and David R. Jessey. Geological Sciences Department, California State Polytechnic University, Pomona
LATE CENOZOIC VOLCANISM NEAR BAKER, CALIFORNIA

Best Papers

Ecology and Evolution: P.G. Matson and M.S. Edwards. Dept. of Biology, San Diego State University
CHANGES IN LATITUDES, CHANGES IN . . . MORPHOLOGY? STIPE HOLLOWING IN *EISENIA ARBOREA* (PHAEOPHYCEAE)

and

R.P. Ferrer and R.K. Zimmer. Dept. of Ecology and Evolutionary Biology, UCLA
THE CALIFORNIA NEWT: NATURAL HISTORY AND CHEMICALLY-MEDIATED INTERACTIONS

Molecular Biology and Physiology: John Christian Fox and **Hee Sun Choi.** Dept. of Emergency Medicine, University of California, Irvine
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Julianne Kalman. Dept of Evology and Evolutionary Biology, UCLA
ECTOPARASITES OF FISHES ASSOCIATED WITH WASTEWATER DISCHARGE IN THE SOUTHERN CALIFORNIA BIGHT

Southern California Academy of Sciences 2006 Session Schedule

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, Elkins Auditorium

Session: Plastics in the Marine Environment

Chair: Capt. Charles Moore, Algalita Marine Research Foundation

1 9:00 **STANDARDIZED METHODS FOR MONITORING PLASTIC IN THE MARINE ENVIRONMENT.** **Zellers, Ann**. Algalita Marine Research Foundation 1021 N Harbor Dr. Redondo Beach, CA 90277.

2 9:20 **PLASTIC DEBRIS, RIVERS TO SEA: AN OVERVIEW OF THE PROP 13 FUNDED PROJECT "ASSESS AND REDUCE SOURCES OF PLASTIC AND TRASH IN URBAN AND COASTAL WATERS".** C.J. Moore, **G.L. Lattin**, A.F. Zellers. Algalita Marine Research Foundation, 148 N. Marina Drive, Long Beach, CA 90803.

3 9:40 **UNRESOLVED TECHNICAL ISSUES IN PLASTICS IN THE MARINE ENVIRONMENT.** **Tony Andrady PhD**. Senior Research Scientist, Research Triangle Institute, Durham, NC 27709.

4 10:00 **MICROBIAL ACTIVITIES IN THE DEEP SEA.** **C.O. Wirsen**. Woods Hole Oceanographic Institution, Biology Department Woods Hole, MA 02543.

5 10:20 **BIODEGRADATION TESTING METHODS FOR POLYMERS IN THE MARINE ENVIRONMENT.** J.A. Ratto, R. Stote, J. Herbert, **C. Thellen,** U.S. Army Natick Soldier Center, Natick, MA. C. Wirsen, Woods Hole Oceanographic Institution, Woods Hole, MA.

6 1:20 **SEABIRDS AS INDICATORS OF PLASTIC POLLUTION IN THE NORTH PACIFIC.** D. Hyrenbach, Duke University Marine Laboratory, Beaufort, NC 28516. C. Keiper, Oikonos Ecosystem Knowledge P.O. Box 979, Bolinas, CA 94924. H. Nevins, BeachCOMBERS, Moss Landing Marine Laboratories, Moss Landing, CA 95039, and Oikonos Ecosystem Knowledge. M. Hester, Oikonos Ecosystem Knowledge. C. Moore, Algalita Marine Research Foundation, 148 N Marina Drive, Long Beach, CA 90803. J. Harvey, BeachCOMBERS, Moss Landing Marine Laboratories, Moss Landing, CA 95039.

7 1:40 **DISTRIBUTION OF ANTHROPOGENIC AND NATURAL DEBRIS ON THE MAINLAND SHELF OF THE SOUTHERN CALIFORNIA BIGHT.** S.L. Moore[1] and S.M. Walther[2]. [1]Southern California Coastal Water Research Project, Westminster, CA, 92683; [2]Los Angeles County Sanitation Districts, Carson, CA 90745.

8 2:00 **INTEGRATING CURRENT SCIENCE INTO SCHOOL CIRRICULUMS.** **Marcus Eriksen**, Algalita Marine Research Foundation, 148 N. Marina Drive, Long Beach, CA 90803. **Amy Frame**, Environmental Charter High School, 4234 W. 147th St., Lawndale, CA 90260.

9 2:20 **HEALTH EFFECTS OF PLASTICS: AN OVERVIEW.** **S.S. Mosko**. Earth Resource Foundation, Costa Mesa, CA 92627.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 215

Session: Atmospheric Deposition

Chair: Lisa Sabin, SCCWRP

152 3:20 **NITROGEN DEPOSITION IN SOUTHERN CALIFORNIA: IMPACTS ON PLANT AND FOREST HEALTH, NUTRIENT CYCLING, WATER QUALITY, AND ECOSYSTEM SUSTAINABILITY.** **Fenn, M.E.*** USDA Forest Service, Pacific Southwest Experiment Station, Riverside, CA.

153 3:40 **DRY AND WET ATMOSPHERIC DEPOSITIONS OF SELECTED INSECTICIDES IN THE SAN DIEGO CREEK–NEWPORT BAY WATERSHED.** **Jay Gan,*** Wenjian Lao, Svetlana Bondarenko, and Fredrick Ernst. Department of Environmental Science, University of California, Riverside.

154 4:00 **THE DRY DEPOSITION AND RESUSPENSION OF PARTICLE-ASSOCIATED TRACE METALS NEAR A FREEWAY IN LOS ANGELES.** **Lisa D. Sabin*** and Kenneth C. Schiff, Southern California Coastal Water Research Project, Westminster, CA. Jeong Hee Lim, Maria Teresa Venezia, Arthur M. Winer, and Keith D. Stolzenbach, University of California, Los Angeles, CA.

155 4:20 **DEPOSITION AND RESUSPENSION PROCESSES ON SURFACE CONTAMINATION AND AIR CONCENTRATION PROFILES.** **Jeong Hee Lim**,* Keith D. Stolzenbach. Civil and Environmental Engineering Department, University of California, Los Angeles, CA.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 210

Session: Contributed Papers–Session 1

Chair: Judy Doino Lemus, Wrigley Institute for Environmental Studies

10 9:00 **CLUES IN A MATCHMAKING MYSTERY: LINKING THE SEXES OF GNATHIID ISOPODS.** **L. Haney**. Los Angeles County Sanitation Districts, Marine Biology Laboratory, Carson, CA, 90745.

11 9:20 **HOLOTHUROID AND ECHINOID AGGREGATE BEHAVIOR ON THE EASTERN PACIFIC ABYSSAL PLAIN.** **K.D. Trego**. Nautilus Oceanic Institute, La Jolla, CA 92037.

12 9:40 **SCALES OF VARIATION IN SMALL FISH MERCURY CONTENT–INITIAL FINDINGS.** **A. Jahn**, B.K. Greenfield, J.L. Grenier and S. Shonkoff. San Francisco Estuary Institute.

13 10:00 **DISTRIBUTION AND IMPORTANCE OF AGE-0 ATHERINOPSID FISHES IN SOUTH-CENTRAL SAN FRANCISCO BAY.** **A. Jahn**, C. Ehrler, and M.L. Elliott. Andrew Jahn Consulting, Ukiah, CA, Tenera Environmental, and PRBO Conservation Science.

14 10:20 **INVESTIGATION OF THE VIRTUAL ELECTRIC CHARGE EFFECT.** **Jennifer Nguyen**. Milpitas High School, 1285 Escuela Parkway, Milpitas, CA 95035.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 210

Session: Rocky Reefs

Chair: Daniel Pondella III, Occidental College

15 E 1:20 **EFFECTS OF VERTICAL DISTRIBUTION ON DISPERSAL POTENTIAL OF KELP SPORES.** **D.K. Cie** and M.S. Edwards. San Diego State University, Department of Biology, San Diego, CA 92182.

16 E 1:40 **CHANGES IN LATTITUDES, CHANGES IN . . . MORPHOLOGY? STIPE HOLLOWING IN *EISENIA ARBOREA* (PHAEOPHYCEAE).** **P.G. Matson** and M.S. Edwards. San Diego State University, Department of Biology, San Diego, CA, 92182.

17 2:00 **DELAYED RECOVERY OF GIANT KELP NEAR ITS SOUTHERN RANGE LIMIT IN THE NORTH PACIFIC FOLLOWING EL NIÑO.** **M.S. Edwards**[1] and G. Hernández-Carmona. [1]Department of Biology, San Diego State University, San Diego, CA 92182 USA; [2]Centro Interdisciplinario de Ciencias Marinas, Ap. Postal 592. La Paz, Baja California Sur 23000, México,

18 2:20 **SANTA MONICA BAY NEEDS YOUR KELP!** **Tom Ford** and Laura Bodensteiner. Kelp Restoration and Monitoring Project, Santa Monica Baykeeper, P.O. Box 10096 Marina Del Rey, CA, 90295.

19 2:40 **CAN WE SAVE THE BIG FISH?** **D.J. Pondella, II**[1] and L.G. Allen[2]. [1]Vantuna Research Group, Department of Biology, Occidental College, Los Angeles, CA 90041; [2]Department of Biology, California State University, Northridge, CA 91330-8303.

20 3:20 **REEF CHECK CALIFORNIA–A TROPICAL MODEL OF COMMUNITY MONITORING IN A TEMPERATE ENVIRONMENT.** **C.S. Shuman**. Reef Check Foundation, 17575 Pacific Coast Highway, Pacific Palisades, CA, 90272.

21 F 3:40 **THE VALUE OF NET-CAGE MARICULTURE AS A FAD IN SOUTHERN CALIFORNIA.** **C.T. Oakes** and D.J. Pondella, II. Vantuna Research Group, Occidental College, Department of Biology, Los Angeles, CA, 90041.

22 4:00 **PRELIMINARY OBSERVATIONS ON THE LIFE HISTORY OF SALEMA *XENISTIUS CALIFORNIENSIS* FROM SOUTHERN CALIFORNIA.** **Eric Miller**[1], Daniel Pondella[2], and Kevin Herbinson[3]. [1]MBC Applied Environmental Sciences, Costa Mesa, CA; [2]Vantuna Research Group, Occidental College, Los Angeles, CA; [3]Southern California Edison, Rosemead, CA.

23 F 4:20 **INDICATORS OF GONAD STATE IN CALIFORNIA SHEEPHEAD (*SEMICOSSYPHUS PULCHER*).** **Kerri A. Loke**, Michael A. Sundberg, Kelly A. Young and Christopher G. Lowe. California State University Long Beach, Long Beach California.

24 4:40 **DISTRIBUTION OF PLANKTON NEAR THE MONTEREY UPWELLING FRONT: RETHINKING THE CONCEPT OF PLANKTON AS INACTIVE "DRIFTERS".** **A.K. Morris**, Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA, 90095.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 240

Session: Contributed Papers–Session 2

Chair: Andrea Murray, CSU Fullerton

25 9:00 **THE EFFECT OF THE SEA WATER WARMING TREND IN THE EASTERN PACIFIC OCEAN ON THREE DIFFERENT BREEDING TYPES OF DEMERSAL MARINE FISHES.** **Mike McCarthy**. CSU Fullerton.

26 E 9:20 **THE RELATIONSHIP BETWEEN EL NIÑO/SOUTHERN OSCILLATION EVENTS AND GROWTH OF JUVENILE WHITE SEABASS (*ATRACTOSCION NOBILIS*).** **Jonathan P. Williams.** California State University, Northridge, Department of Biology, 18111 Nordhoff St., Northridge, CA, 9.

27 E 9:40 **LIFE HISTORY PARAMETERS AND COURTSHIP BEHAVIOR OF BLACK PERCH (*EMBIOTOCA JACKSONI*) WITHIN THE SOUTHERN CALIFORNIA BIGHT.** **Froeschke, Bridgette F.** Nearshore Marine Fish Research Program, California State University, Northridge, Department of Biology, 18111 Nordhoff St. Northridge CA, 91330.

28 E 10:00 **THINK SMALL: BENEFITS OF APPROACHING THE POPULATION GENETICS OF THE TIDEWATER GOBY (*EUCYCLOGOBIUS NEWBERRYI*) FROM THE LEVEL OF THE INDIVIDUAL.** **Dent A. Earl**, David K. Jacobs, Kristina D. Louie, Carolyne Bardeleben, Carles Vila & Camm C. Swift. Presenter's Contact: UCLA, Ecology and Evolutionary Biology Department, 621 Charles E. Young Drive South, Los Angeles, CA 90095. 310-206-7885, daearl@ucla.edu.

29 E 10:20 **THE EFFECTS OF DIEL AND TIDAL CYCLES ON THE ABUNDANCE OF HARBOR SEALS, *PHOCA VITULINA RICHARDSI,* IN CHALK COVE, SANTA CATALINA ISLAND.** **A. Floyd**. Dept. of Biological Sciences, California State University Long Beach, Long Beach, CA 90840.

30 M 1:20 **PLASMA TESTOSTERONE LEVELS CORRELATE WITH SPERMATOGENESIS BUT NOT GSI IN MALE ROUND STINGRAYS (*UROBATIS HALLERI*).** **C.G. Mull**, C.G. Lowe, and K.A. Young. Department of Biology, California State University, Long Beach 90840.

31 M 1:40 **CRANIAL ENDOTHERMY IN THE MOONFISH (*LAMPRIS GUTTATUS*).** **Runcie, Rosa M.**[1], Dickson, Kathryn A.[1], Dewar, Heidi[2], and Hawn, Don[3]. [1]Department of Biological Science, CA State University Fullerton, Fullerton, CA 92831; [2]Inter-American Tropical Tuna Commission, La Jolla, CA 92037; [3]National Marine Fisheries Service, Honolulu, HI 96814.

32 M 2:00 **THE POTENTIAL FOR LACTATE PROCESSING IN WHITE MUSCLE OF ENDOTHERMIC AND ECTOTHERMIC SHARKS.** **J.M. Backey** and K.A. Dickson. California State University, Department of Biological Science, Fullerton, CA, 92831.

33 2:20 **'BUT YOU CAN'T TAKE THE COUNTRY OUT OF THE LARVA': SITE EFFECTS IN CALCIFIED STRUCTURES USEFUL FOR LARVAL TRACKING STUDIES.** **D.C. Lloyd** and D.Z. Zacherl, Department of Biological Science, California State University, Fullerton, CA 92831. Georges Paradis and Mike Sheehy, MSI, University of California Santa Barbara. Robert Warner, EEMB, University of California, Santa Barbara 93106.

34 E 2:40 **ECTOPARASITES OF FISHES ASSOCIATED WITH WASTEWATER DISCHARGE IN THE SOUTHERN CALIFORNIA BIGHT.** **J.E. Kalman**. University of California Los Angeles, Department of Ecology and Evolutionary Biology, Los Angeles, CA 90095, and Orange County Sanitation District, Fountain Valley, CA 92708.

35 M 3:20 **THE OPTIC NERVE SHEATH DIAMETER IN ASSOCIATION WITH INCREASED INTRACRANIAL PRESSURE.** **Jarrod Larson**, Mauricio Arcila, Elana Neches, John C. Fox, and Lynn Lulloff. University of California, Irvine Medical Center, Department of Emergency Medicine, Orange, CA, 92868.

36 3:40 **THE RESPONSE OF FLYING INSECTS TO SCORPION FLUORESCENCE.** **C.T. Kloock.** California State University, Bakersfield, Department of Biology, Bakersfield CA, 93311.

139 M 4:00 **USE OF ULTRASOUND TO RISH-STRATIFY PREGNANCY OUTCOME IN EMERGENCY DEPARTMENT PATIENTS WITH FIRST TRIMESTER VAGINAL BLEEDING.** John Christian Fox, MD, Department of Emergency Medicine University of California, Irvine research group. **Choi, Hee Sun**, 200 South Manchester Orange, CA 92868.

141 4:20 **HAS THE STATE BAN ON AQUARIUM *CAULERPA* SPECIES BEEN EFFECTIVE IN SOUTHERN CALIFORNIA?** **J.R. Smith**[1], S.F. Zaleski[2], S. Diaz[1], L.J. Walters[3], K. Brown[3], and S.N. Murray[1]. [1]Department of Biological Science, California State University, Fullerton, CA 92834; [2]Sea Grant Program, University of Southern California, Los Angeles, CA 90089; [3]Department of Biology, University of Central Florida, Orlando, FL 32816.

142 E 4:40 **MUSCULATURE OF THE MODIFIED RIB FOUND IN CYPRINIFORM FISHES.** **R.L. Perry.** California State University Bakersfield, Department of Biology, Bakersfield, CA 93311.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 215

Session: Invasive Species

Chair: Shelley Luce, Santa Monica Bay Restoration Commission

38 9:00 **CHEMICAL AND NON-CHEMICAL METHODS FOR REMOVING INVASIVE PLANTS: TWO CASE STUDIES.** **Nat Cox.** Environmental Scientist, California State Parks, Angeles District.

39 9:20 **THE BRADLEY METHOD OF "BUSH" REGENERATION.** **Jo Kitz.** Program Director, Mountains Restoration Trust.

40 9:40 **USING INTEGRATED VEGETATION MANAGEMENT TO CONTROL NON-NATIVE INVASIVE SPECIES AND RESTORE NATIVE ECOSYSTEMS IN THE SANTA MONICA MOUNTAINS.** **Marti Whitter.** Fire Ecologist, National Parks Service.

41 10:00 **Ellen Mackey.** Field Ecologist/Biologist, Los Angeles & San Gabriel Rivers Watershed Council.

10:20 **Panel Discussion: Selecting Methods for Invasive Plant Management.** **Moderated by Shelley Luce,** Director, Santa Monica Bay Restoration Commission.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, KSC 130

Session: Southern California Coastal Stream Vertebrates: Biology and Conservation

Session Chair: Jonathan Baskin,
California State Polytechnic University, Pomona

Introduction: Jonathan Baskin, California State Polytechnic University, Pomona.

42 1:40 **ROLE OF WATERSHED-SCALE PHYSICAL PROCESSES IN SHAPING HABITAT REQUIREMENTS OF RIPARIAN DEPENDENT FAUNA.** E.D. Stein. Southern California Coastal Water Research Project, 7171 Fenwick Lane, Westminster, CA, 92683.

43 2:00 **STATUS AND DISTRUBUTION OF THE INLAND FISHES OF COASTAL SOUTHERN CALIFORNIA.** Camm C. Swift, ENTRIX, Inc., 2140 Eastman Avenue, Suite 200, Ventura, CA 93003, (626) 447-5846. Jonathan N. Baskin, Biological Sciences Department, Cal Poly Pomona University, 3801 W. Temple Ave., CA 91768, 909 869-4045, and San Marino Environmental Associates, 560 South Greenwood Ave., San Marino, CA 91108. Robert Fisher, USGS, San Diego Field Station, U.S. Geological Survey, 4165 Spruance Road, Suite 200, San Diego, CA 92101-0812, 619-225-6422. Thomas Haglund, Biological Sciences Department, Cal Poly Pomona University, 3801 W. Temple Ave., CA 91768, 818-906-3440, and San Marino Environmental Associates, 560 South Greenwood Ave., San Marino, CA 91108.

44 2:20 **STATUS, DISTRIBUTION, HABITAT AND POPULATION SIZE-STRUCTURE ESTIMATES FOR THE THREATENED SANTA ANA SUCKER (*CATOSTOMUS SANTAANAE*).** J.N. Baskin, S.H. Bryant, T.R. Haglund, Biological Sciences Department, Cal Poly Pomona University, 3801 W. Temple Ave., Pomona, CA 91768, and San Marino Environmental Associates, 560 South Greenwood Ave., San Marino, CA 91108. Camm C. Swift, ENTRIX, Inc., 2140 Eastman Avenue, Suite 200, Ventura, CA 93003.

45 2:40 **STATUS OF THE SANTA ANA SUCKER (*CATOSTOMUS SANTAANAE*) IN SOUTHERN CALIFORNIA: PATTERNS AND TRENDS IN CONDITION INDEX AND HABITAT PREFERENCE THROUGHOUT ITS RANGE.** J.N. Baskin, S.H. Bryant, T.R. Haglund. Biological Sciences Department, Cal Poly Pomona University, 3801 W. Temple Ave., Pomona, CA 91768, and San Marino Environmental Associates, 560 South Greenwood Ave., San Marino, CA 91108.

46 3:20 **RARE OCCURRENCES OF A COMMON SPECIES: SPECKLED DACE AND THEIR STRUGGLE FOR SURVIVAL IN SOUTHERN CALIFORNIA.** **G. Abbas.** San Bernardino National Forest, 1824 S Commercenter Cir, San Bernardino, CA 92408.

47 3:40 **TIDEWATER GOBY SEASONAL HABITAT PREFERENCES IN A NORTHERN CALIFORNIA LAGOON, WITH REFERENCE TO ARTIFICIAL BREACHING.** C.A. Page and B.R. Norman. Aquatic Resource Specialists, Environmental Consultants, 12580 HWY 101, Smith River CA, 95567.

48 4:00 **IMPACTS OF EXOTIC SPECIES ON NATIVE AQUATIC SPECIES DISTRIBUTION IN TWO SOUTHERN CALIFORNIA RIVER SYSTEMS.** T.P. Keegan. ECORP Consulting, Inc., 2260 Douglas Blvd., Suite 160, Roseville, CA 95661.

49 4:20 **EXTENT OF FISHING AND FISH CONSUMPTION IN VENTURA AND LOS ANGELES COUNTY WATERSHEDS IN 2005.** M.J. Allen, E.T. Jarvis, V. Raco-Rands, and G. Lyons. Southern California Coastal Water Research Project, Westminster, CA 92683.

50 E 4:40 **THE CALIFORNIA NEWT: NATURAL HISTORY AND CHEMICALLY-MEDIATED INTERACTIONS.** R.P. Ferrer and R.K. Zimmer. Zimmer Laboratory, UCLA, Department of Ecology and Evolutionary Biology, Los Angeles, CA 90095.

Friday, May 12, 2006
Location Seaver Undergraduate Campus, AC 235
Session: Urban Watershed, Runoff Sampling

Chair: Eric Stein, SCCWRP

51 9:00 **USING STREAM CHEMISTRY TO UNDERSTAND WATERSHED DYNAMICS.** **Helen Jung**, Terri Hogue, University of California at Los Angeles. Laura Rademacher, University of Pacific. Sheila Morrissey, University of California at Santa Barbara. Tom Meixner, University of Arizona.

52 9:20 **INNOVATIVE MONITORING TECHNIQUES TO ASSESS WATER QUALITY LOADINGS FROM NATURAL LANDSCAPES.** **Sean A. Porter** and Jay Shrake. MACTEC Engineering and Environmental Consulting, Inc., San Diego, CA 92123.

53 9:40 **WATERSHED-BASED SOURCES OF TOTAL COPPER, LEAD AND ZINC IN URBAN STORMWATER.** **L.L. Tiefenthaler**, E.D. Stein and K. Schiff. Southern California Coastal Water Research Project, 7171 Fenwick Lane, Westminster, CA, 92683.

54 10:00 **STORMWATER TOXICITY EVALUATION OF MAJOR RIVERS ENTERING THE SOUTHERN CALIFORNIA BIGHT.** John Rudolph[1], **Chris Stransky**[1], Howard Bailey[1], Steve Bay[2], and Darrin Greenstein[2]. [1]Nautilus Environmental, San Diego, CA, 92121; [2]Southern California Coastal Water Research Project, Westminster, CA, 92683.

55 10:20 **QUANTITATIVE MICROBIAL SOURCE TRACKING USING *BACTEROIDALES* AND HUMAN VIRUS MONITORING IN CALLEGUAS CREEK WATERSHED.** Beverly Kildare and Stefan Wuertz, Department of Civil and Environmental Engineering, University of California, Davis, CA 95616. **Dustin Bambic**, Larry Walker Associates, 250 Lafayette Circle Suite 200, Lafayette, CA 94549.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 235
Session: River Dynamics and Runoff Plumes in Marine Environments

Chair: Burton Jones, University of Southern California

56 1:20 **DRY WEATHER RIVER RUNOFF IN THE SOUTHERN CALIFORNIA BIGHT.** **Burton Jones.** Marine Environmental Biology University of Southern California.

57 1:40 **SATELLITE VIEW OF STORMWATER RUNOFF PLUMES IN SOUTHERN CALIFORNIA.** **Nikolay P. Nezlin.** Southern California Coastal Water Research Project, 7171 Fenwick Lane, Westminster, CA 92683-5218 USA.

58 2:00 **THE EFFECTS OF STORMWATER RUNOFF IN SANTA MONICA BAY.** **K.M. Reifel** and B.H. Jones. University of Southern California, Department of Biology, Los Angeles, CA 90089-0371.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 235
Session: Red Tides

Moderator: Rick Pieper, Southern California Marine Institute

59 2:20 **HARMFUL ALGAE IN THE SOUTHERN CALIFORNIA BIGHT: PRESENT THREATS AND FUTURE CONCERNS.** **David A. Caron**, Astrid Schnetzer, Rebecca Schaffner, Steffi Moorthi, Peter Countway, Beth Stauffer, Adriane Jones, Diane Kim and Billy Pan. Department of Biological Sciences, University of Southern California, 3616 Trousdale Parkway, Los Angeles, CA 90089-0371.

60 2:40 ***PSEUDONITZSCHIA* AND DOMOIC ACID IN THE LOS ANGELES HARBOR AND ADJACENT COASTAL WATERS.** **Astrid Schnetzer**, David A. Caron, Peter E. Miller, Rebecca Schaffner, Adriane Jones, Diane Kim and Billy Pan, Department of Biological Sciences, University of Southern California, 3616 Trousdale Parkway, Los Angeles, CA 90089-0371. Stephen Weisberg, Southern California Coastal Water Research Project, Westminster, CA 92683.

61 3:20 **DOMOIC ACID TOXICITY IN CALIFORNIA SEA LIONS (*ZALOPHUS CALIFORNIANUS*) STRANDED IN ORANGE COUNTY, CA, 2002–2006.** **Richard Evans,** Michele Hunter and Meg Jones. Pacific Marine Mammal Center, 20612 Laguna Canyon Road, Laguna Beach, CA 92651.

62 3:40 **DOMOIC ACID POISONING IN SEABIRDS.** **Susan Kaveggia.** International Bird Rescue Center, 3601 South Gaffey Street, San Pedro, CA 90731.

63 4:00 **RED TIDE BLOOMS (*LINGULODINIUM POLYEDRA*) IN SAN PEDRO BAY.** **Ivona Cetinic**, Astrid Schnetzer, David A. Caron and Burt Jones. University of Southern California, Los Angeles, CA 90089 USA.

64 4:20 **THE WATER QUALITY TASK FORCE IN REDONDO BEACH; HOW A SMALL COASTAL CITY IS DEALING WITH RED TIDES AND FISH KILLS.** **Chris Cagle**. Councilman, City of Redondo Beach, 415 Diamond Street, Redondo Beach, CA 90277.

65 4:40 **SOME ASPECTS OF MONITORING FOR TOXIC AND NONTOXIC BLOOMS (THE HABS AND THE HAB-NOTS) IN CALIFORNIA.** **Gregg W. Langlois.** California Department of Health Services, 850 Marina Bay Parkway, Richmond, CA. 94804.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 205

Session: Sediment Quality Objectives

Chair: Steve Bay, SCCWRP

66 1:20 **GOALS AND OBJECTIVES OF CALIFORNIA'S SEDIMENT QUALITY OBJECTIVES PROGRAM.** **Beegan, Chris**. State Water Resources Control Board, Sacramento, California.

67 1:40 **COMPARISON AND SELECTION OF SUBLETHAL SEDIMENT TOXICITY TESTS FOR USE IN EVALUATING SEDIMENT QUALITY.** **D. Young**,* S.M. Bay, and D. Greenstein. Southern California Coastal Water Research Project, Westminster CA.

68 2:00 **A MEASURE OF BENTHIC INVERTEBRATE COMMUNITY CONDITION FOR CALIFORNIA BAYS AND ESTUARIES.** **J.A. Ranasinghe**[1], S.B. Weisberg[1], R.W. Smith[2], D.E. Montagne[3], B. Thompson[4], J.M. Oakden[5], D.D. Huff[6], and C. Beegan[7]. [1]SCCWRP, Westminster, CA; [2]Deceased; [3]County Sanitation Districts of Los Angeles County, Whittier, CA; [4]San Francisco Estuary Institute, Oakland, CA; [5]Moss Landing Marine Laboratory, Moss Landing, CA; [6]Oregon Dept. of Environmental Quality, Portland, OR; [7]State Water Resources Control Board, Sacramento, CA.

69 2:20 **DEVELOPMENT AND EVALUATION OF CHEMICAL SQGS BASED ON BENTHIC MACROFAUNA RESPONSES TO SEDIMENT CHEMISTRY.** **Kerry J. Ritter**,* Steven M. Bay, and Robert W. Smith. Southern California Coastal Water Research Project, Westminster, CA.

70 2:40 **DEVELOPMENT AND VALIDATION OF A MULTIPLE LINE OF EVIDENCE FRAMEWORK FOR INTEGRATING SEDIMENT QUALITY DATA.** **Steven M. Bay***, Stephen B. Weisberg, and Jeff Brown. Southern California Coastal Water Research Project, Westminster, CA.

Friday, May 12, 2006
Location: Seaver Undergraduate Campus, AC 235

Session: Volunteer Monitoring

Chair: Lan Wiborg, City of San Diego

71 3:20 **CITIZEN MONITORING STATUS AND TRENDS.** **Erick Burres**. State Water Resources Control Board.

72 3:40 **CITIZEN VOLUNTEER BASED BENTHIC MACROINVERTEBRATE WATER QUALITY SAMPLING.** **Rob Roy**.* Coordinator, San Diego Stream Team, San Diego, CA.

73 4:00 **RECOVERY OF THE WESTERN SNOWY PLOVER AT SAND'S BEACH, COAL OIL POINT RESERVE, SANTA BARBARA, CALIFORNIA.** **Jennifer Stroh.** Santa Barbara Audubon Society & University of California's Natural Reserve System, Santa Barbara, California.

74 4:20 **RAPID ACQUISITION OF CITIZEN SCIENTIST DATA ACROSS LARGE DISTANCES: GRUNION GREETERS AND THE INTERNET ALONG THE CALIFORNIA COAST.** **K.L. Martin**, B. Cupp, C. Stivers, M. Studer. Pepperdine University, Natural Science Division, Malibu, CA 90263-4321.

75 4:40 **A THREE YEAR STUDY OF SEASONAL BACTERIAL CONCENTRATIONS USING VOLUNTEER ASSISTANCE.** **L. Gilbane**, K.A. Snow, S. Aizawa, K.E. Flaherty, Y.J. Ralph, C.V. Wolfe, K. Kull and R.E. Pieper. Southern California Marine Institute, Terminal Island, CA, 90731.

Friday, May 12, 2006

Location: Seaver Undergraduate Campus, Fireside Room

Session: Poster Session–Presenting SCAS and SETAC Posters

76 **FIRE-FLOOD-FISH: LOSS AND PERSISTENCE OF UPPER SANTA ANA RIVER SPECKLED DACE (*RHINICHTHYS OSCULUS*) IN SOUTHERN CALIFORNIA AND THE VALUE OF TIMELY HUMAN INTERVENTION.** **G. Abbas**[1], J.N. Baskin[2], R.N. Fisher[3], R. Maloney-Rames[4], A.E. Metcalf[5], R. Rodriguez[6] and C.C. Swift[7], Southern California Native Freshwater Fauna Working Group. [1]San Bernardino National Forest, 1824 S Commerce Center Cir, San Bernardino, CA 92408, (909) 382-2620, gabbas@fs.fed.us; [2]Cal Poly University Pomona, 3801 W. Temple Ave., Pomona, CA 91768, and San Marino Environmental Associates, (626) 826-8226, jnbaskin@csupomona.edu; [3]U.S. Geological Survey, San Diego Field Station, 4165 Spruance Road, Suite 200, San Diego, CA 92101-0812, 619-225-6422, rfisher@usgs.gov; [4]California Department of Fish and Game, 3602 Inland Empire Blvd., Ste C-220, Ontario, CA 91764, (909) 980-3818, rmaloney@dfg.ca.gov; [5]California State University San Bernardino, 5500 University Parkway San Bernardino, CA 92407, (909) 537-7501, ametcalf@csusb.edu; [6]California Department of Fish and Game, 3602 Inland Empire Blvd., Ste C-220, Ontario, CA 91764, (909) 484-0523, rrodriguez@dfg.ca.gov; [7]ENTRIX, Inc., 2140 Eastman Avenue, Suite 200, Ventura, CA 93003, (626) 447-5846, cswift@entrix.com.

77 E **TOOTH FRACTURE AND WEAR COMPARED IN A RANCHO LA BREA SABER-TOOTHED CAT AND THE DIRE WOLF.** **J.E. Abellera, E.A. Ibrahim** and W.J. Binder. Loyola Marymount University, Department of Biology, Los Angeles, CA, 90045.

78 E **EFFECTS OF OFF-HIGHWAY VEHICLE ACTIVITY ON THE MOJAVE DESERT BIOTA.** **Amy J. Arispe** and Stephanie H. Diaz. Southern California Ecosystems Research Program, Department of Biological Sciences, California State University, Fullerton.

79 P **LATE CENOZOIC VOLCANISM NEAR BAKER, CA.** **Baltzer, Suzanne M.** and Jessey, David R. Geological Sciences Department, California State Polytechnic University–Pomona, Pomona, CA 91768.

80 E **THE EFFECT OF FEMALE CRICKET CHEMICAL CUES ON THE AGGRESSIVE BEHAVIOR OF MALE CRICKETS, *ACHETA DOMESTICUS*.** **Leslie J. Buena** and Sean E. Walker. California State University, Fullerton.

81 **WATER AND SEDIMENT QUALITY EVALUATION OF THE SANTA CLARA RIVER ESTUARY–ANALYSIS OF IMPACTS ASSOCIATED WITH THE DISCHARGE OF TREATED WASTEWATER.** **Colvin, Molly;** Bailey, Howard C.; and Stransky, Chris. Nautilus Environmental, San Diego, CA.

82 E **COMPARATIVE ANALYSES OF THE ENTIRE MITOCHONDRIAL *cox*-I GENE SEQUENCE ACROSS VARIOUS GENERA OF CHITONS.** **N.V. Dabbousi** and D.J. Eernisse. Department of Biological Science, California State University, Fullerton, Fullerton, CA 92834-6850.

83 **SEX DIFFERENCES AND GEOGRAPHIC VARIATION IN BODY SIZE IN THE WOLF SPIDERS *RABIDOSA RABIDA* AND *RABIDOSA PUNCTULATA* (ARANEAE: LYCOSIDAE).** **Gerry Del Rio Cortes** and Sean E. Walker. Department of Biological Sciences, California State University, Fullerton, Fullerton, CA 92831.

84 M **DIFFERENTIAL EFFECTS TO DOPAMINE OXIDATION IN PC12 CELLS AND PRIMARY ASTROCYTES: A MODEL FOR NEURODEGENERATION?** **Jessica De Giacomo**[1], Jerome Garcia[1], and Enrique Cadenas[2]. [1]Biology Department, School of Arts & Sciences, University of La Verne, Los Angeles, CA 91750, USA; [2]Molecular Pharmacology & Toxicology, School of Pharmacy, University of Southern California, Los Angeles, CA 9008, USA

85 P **PLEISTOCENE STRATIGRAPHY AND PALEOENVIRONMENT OF BAHIA SAN QUINTIN, BAJA CALIFORNIA, MEXICO.** **R.V. Di Fiori.** Ecology and Paleoecology Research Group, Pasadena City College, Natural Science Division, Pasadena, CA 91106.

86 **EVALUATION OF ECOLOGICAL AND HYDROLOGICAL CONDITIONS IN THE SANTA CLARA RIVER ESTUARY WITH RESPECT TO DISCHARGE OF TREATED EFFLUENT.** **Douglass, Sarah**[1]*; Bailey, Howard C.[1]; Kamman, Greg[2]; and Pfeifer, Dan[3]. [1]Nautilus Environmental, San Diego, CA; [2]Kamman Hydrology and Engineering, Inc., San Rafael, CA; [3]City of San Buenaventura, Ventura, CA.

87 **TIERED AQUATIC LIFE USES FOR SOUTHERN CALIFORNIA COASTAL STREAMS.** Jerry Diamond, Ph.D., Tetra Tech, Inc., 400 Red Brook Boulevard, Suite 200, Owings Mills, MD 21117, jerry.diamond@tetratech.com. Renee Purdy DeShazo, Los Angeles Regional Water Quality Control Board, 320 W. 4th Street, Suite 200, Los Angeles, CA 90013, rdeshazo@waterboards.ca.gov. **Sabrina Drill,** University of California Cooperative Extension, 4800 E. Cesar Chavez Ave., Los Angeles, CA 90022, sldrill@ucdavis.edu.

88 M **DETAILED COMPOSITIONAL COMPARISON OF ACIDIC NSO COMPOUNDS IN BIODEGRADED VERSUS NON-BIODEGRADED ENVIRONMENTAL SAMPLES USING NEGATIVE ION ELECTROSPRAY FOURIER TRANSFORM ION CYCLOTRON RESONANCE MASS SPECTROMETRY.** **S.A. Galasso** and C.A. Hughey. Chapman University, Department of Physical Sciences, 1 University Dr., Orange, CA 92866.

89 **EFFECTS OF SALINITY CONCENTRATION ON RATES OF POLYP CLONING, GROWTH, AND STROBILATION IN THE *AURELIA LABIATA* (CNIDARIA, SCYPHOZOA).** **Julie A. Guerin.** Cabrillo Marine Aquarium, San Pedro, CA 90731; Palos Verdes Peninsula High School, Rolling Hills Estates, CA 90274.

90 E **ASSESSMENT OF THE SELF-PURIFICATION OF A CONSTRUCTED WETLANDS AND THE EFFECTS OF POLLUTION ON THE BIOLOGICAL COMMUNITY.** **I.R. Hajjali,** S.A. Cardenas, T.A. Voung, R.B. Shah, J.Z. Liu, W.S. Liang, M.R. Robles, J.E. Krayer, L.A. Del Valle, and A. Lam. Ecology and Paleoecology Research Group, Pasadena City College, Natural Science Division, Pasadena, CA. 91106.

91 E **A PRELIMINARY STUDY OF PLASTICS POLUTION IN THE COASTAL WATERS AND BEACHES OF BAJA CALIFORNIA PENINSULA. ESTUDIOS PRELIMINARES DE CONTAMINACIÓN POR PLÁSTICOS EN AGUAS COSTERAS Y PLAYAS DE LA PENÍNSULA DE BAJA CALIF0RNIA MÉXICO.** Oce. **A. Raúl Herrera-Gutiérrez,** Cap. Charles Moore, M.C. Gustavo Riaño-Sánchez. Algalita Research Foundation and Asesores en Biología Pesquera, S.A. de C.V, BIOPESCA.

92 F **ANGLING-INDUCED BAROTRAUMA AND INITIAL CATCH SURVIVAL OF SOUTHERN CALIFORNIA NEARSHORE AND SHELF ROCKFISHES (SCORPAENIDAE, *SEBASTES* SPP.).** **Jarvis, E.T.** and C.G. Lowe. California State University, Long Beach, Department of Biology, Long Beach, CA, 90840.

93 M **CAN MEDICAL STUDENTS LEARN AND RETAIN BEDSIDE ULTRASOUND? THE EVALUATION OF A FOURTH YEAR MEDICAL STUDENT ELECTIVE IN EMERGENCY ULTRASOUND.** **Jarrod Larson,** Graciela Barajas and John C. Fox. University of California, Irvine Medical Center, Department of Emergency Medicine, Orange, CA, 92868.

94 F **ECTOPARASITES OF THE CALIFORNIA SCORPIONFISH, *SCORPAENA GUTTATA,* IN THE SOUTHERN CALIFORNIA BIGHT.** **J.E. Kalman.** University of California Los Angeles, Department of Ecology and Evolutionary Biology, Los Angeles, CA 90095, and Orange County Sanitation District, Fountain Valley, CA 92708.

95 M **MICROSATELLITE DNA ASSESSMENT OF MULTIPLE PATERNITY IN THE VIVPAROUS ROCKFISH *SEBASTES MELANOPS.*** **Kurt W. Karageorge.** Department of Biological Sciences, California State University, Long Beach, Long Beach, CA 90840.

96 E **THE INFLUENCE OF ARTICHOKE THISTLE ON HUMMINGBIRD POPULATIONS.** R.J. Keber and S.A. Banack. Southern California Ecosystems Research Program, California State University, Fullerton, Department of Biological Science, Fullerton, CA, 92834.

97 A **RETROSPECTIVE ANALYSIS OF GALLBLADDER PATHOLOGY USING BEDSIDE ULTRASOUND.** Jarrod Larson, Graciela Barajas, John C. Fox, and William Scruggs. University of California, Irvine Medical Center, Department of Emergency Medicine, Orange, CA, 92868.

98 E **EUPHAUSIID SWARMS IN THE MONTEREY SUBMARINE CANYON AS SAMPLED WITH A REMOTELY OPERATED VEHICLE.** J.J. Lee. University of California, Los Angeles, Department of Ecology and Evolutionary Biology, Los Angeles, CA, 90095. J. Ryan, Monterey Bay Aquarium Research Institute, Moss Landing, CA, 95039. W.M. Hamner, University of California, Los Angeles, Department of Ecology and Evolutionary Biology, Los Angeles, CA, 90095. G. Matsumoto, Monterey Bay Aquarium Research Institute, Moss Landing, CA, 95039. B. Robison, Monterey Bay Aquarium Research Institute, Moss Landing, CA, 95039.

99 F **EFFECTS OF ALTERED SALINITY DURING INCUBATION ON CALIFORNIA GRUNION, *LEURESTHES TENUIS*.** J.K. Matsumoto and K.L. Martin. Natural Science Division, Pepperdine University, Malibu, 90263.

100 E **RELATIONSHIPS BETWEEN BODY SIZE AND SOUND PRODUCING STRUCTURES IN CRICKETS: DO BIG MALES HAVE BIG HARPS?** N.R. Moradian and S.E. Walker. Department of Biological Sciences, California State University, Fullerton, Fullerton, CA 92831.

101 E **LINKING THE STATOLITH CHEMISTRY OF *APLYSIA CALIFORNICA* TO WATERSHED DISCHARGE PLUMES ALONG THE OPEN COAST.** M.O. Navarro, G. Paradis, D.W. Lea, M. Sheehy, R.R. Warner, S.D. Gaines and D.C. Zacherl. California State University Fullerton, University of California Santa Barbara.

102 F **PHYLOGENETIC STUDY OF THE FLATFISH GENUS *PLEURONICHTHYS*.** **J.D. Olson.** University of California, Los Angeles, Department of Ecology and Evolutionary Biology, Los Angles, CA 90095-1606.

103 M **AN *IN VITRO* RISK ASSESSMENT MODEL FOR THE IMPACT OF PESTICIDES ON THE DEVELOPMENT OF T CELLS IN C57BL/6 MICE.** **Joan Ordonez*** and Christine Broussard, Ph.D. Department of Biology, The University of La Verne, La Verne, California 91750.

104 M **DETECTION OF QUORUM-SENSING COMPOUNDS IN PLANT-ASSOCIATED MICROORGANISMS.** M.R. Oseguera, N. Chinchillas and G. Brelles-Mariño. Biological Sciences Department, California State Polytechnic University, Pomona, CA 91766.

105 F **THE USE OF MICROSATELLITE MARKERS TO EVALUATE THE GENETIC POPULATION STRUCTURE OF THE ROUND STINGRAY AT SEAL BEACH, CA.** S.M. Plank, C.G. Lowe, J.A. Brusslan. California State University Long Beach, Department of Biological Sciences, Long Beach, CA 90840-3702.

106 M **GSNO FORMATION IN ASTROCYTES AND NEURONS–IMPLICATION FOR NEUROTOXICITY.** Taylor Pupka[1], Li-Peng Yap[2], Jerome Garcia[1], and Enrique Cadenas[2]. [1]Department of Biology, University of La Verne, 1950 3rd St. La Verne, CA 91750-4401; [2]Molecular Pharmacology and Toxicology, School of Pharmacy, University of Southern California, Los Angeles, CA 90089-121.

107 M **GLUTATHIONE TRANSFERASE ACTIVITY IN 3 SPECIES OF SEA TURTLES, *CHELONIA MYDAS AGASSIZII, LEPIDOCHELYS OLIVACEA,* AND *CARETTA CARETTA,* FROM THE BAJA CALIFORNIA PENNISULA.** Kristine L. Richardson*[1], Susan C. Gardner[2], and Daniel Schlenk[1]. [1]University of California–Riverside, Riverside, CA 92521, USA; [2]Centro de Investigaciones Biológicas del Noroeste, S.C., La Paz, Baja California Sur CP 23090, Mexico.

108 E **FIREBREAKS AND INVASIVE PLANT SPECIES.** Moy Mckayla Sab, Ayse Bassari and Cheryl Swift. Department of Biology, Whittier College, Whittier, CA, 90608.

109 E **AN OBSERVATION OF OYSTER SETTLEMENT OVER SEASONS FOR THE WEST COAST OYSTER, *OSTREA CONCHAPHILA*.** E.M. Seale and D. Zacherl. Southern California Ecosystems Research Program, California State University, Fullerton, Department of Biological Sciences, Fullerton, CA, 92831.

110 E **AN APPLICATION OF ISLAND BIOGEOGRAPHY THEORY TO RIPARIAN RESTORATION.** **Jane Shevtsov** and Richard F. Ambrose. UCLA, Department of Ecology and Evolutionary Biology and Department of Environmental Health Sciences, Los Angeles, CA 90095.

111 P **PETROLOGY AND GEOCHEMISTRY OF THE BIG PINE VOLCANIC FIELD, INYO COUNTY, CALIFORNIA.** **Varnell, Ashley E.,** and Jessey, David R. Geological Sciences Department, California State Polytechnic University–Pomona, Pomona, CA 91768.

112 P **REAL-TIME OCEANOGRAPHIC MONITORING NEAR POINT FERMIN AND THE LOS ANGELES RIVER MOUTH.** **A. Vaux**, L. Gilbane, R.E. Pieper, A. Willingham, K. Grubert, S. Kelly. Southern California Marine Institute, Terminal Island, CA, 90731.

113 F **THE EFFECTS OF SELECTIVE FISHING PRESSURE ON THE POPULATION DYNAMICS AND LIFE HISTORY PARAMETERS OF THE CALIFORNIA SHEEPHEAD, *SEMICOSSYPHUS PULCHER*.** **Lynne Wetmore**. Vantuna Research Group, Occidental College, Department of Biology, Los Angeles, CA, 90041.

114 **CHANGES IN DENSITIES OF FECAL INDICATOR BACTERIA (FIB) OVER DIFFERING TIDAL FLOWS IN THE BALLONA WETLANDS, LOS ANGELES.** **S. Yanamadala**[1] and John H. Dorsey[2]. [1]Chadwick High School, 26800 S. Academy Drive, Palos Verdes Peninsula, CA, 90274; [2]Loyola Marymount University, Department of Natural Sciences, Los Angeles, CA, 90045.

115 **USING SOLID-PHASE MICROEXTRACTION TO DETERMINE THE BIOAVAILABILITY OF PYRETHROID INSECTICIDES IN SEDIMENT.** **Hunter, Wesley S.*** and Gan, Jay. University of California, Riverside, CA.

116 **ENANTIOSELECTIVE INHIBITION OF ACETYLCHOLINESTERASE BY CHIRAL ORGANOPHOSPHORUS INSECTICIDES.** **Mae Grace Nillos***, Gabriela Rodriguez-Fuentes, Daniel Schlenk and Jay Gan. University of California, Riverside, CA.

117 **AN ANOLE LIZARD (SQUAMATA: POLYCHROTIDAE) PRESERVED IN COLOMBIAN COPAL.** **W. Chun.** University of California, Los Angeles, Department of Ecology and Evolutionary Biology, Los Angeles, CA, 90095.

Saturday, May 13, 2006
Location: Seaver Undergraduate Campus, Elkins Auditorium

Session: Plastics in the Marine Environment

Chair: Capt. Charles Moore, Algalita Marine Research Foundation

118 9:00 **SYNTHETIC POLYMERS IN THE MARINE ENVIRONMENT: WHAT WE KNOW–WHAT WE NEED TO KNOW.** **Charles Moore**. Algalita Marine Research Foundation, 148 N. Marina Drive, Long Beach, CA 90803.

119 9:20 **CHARACTERIZING AND SURVEYING OCEANIC SOURCES AND SINKS OF MARINE DEBRIS.** **D.G. Foley**, Joint Institute for Marine and Atmospheric Research, University of Hawaii, 1000 Pope Rd., Honolulu, HI 96822. T. Veenstra, Airborne Technologies Inc, Wasilla, AK.

120 9:40 **LONG-TERM TRAJECTORIES OF PLASTIC FLOTSAM IN THE NORTH PACIFIC OCEAN CALCULATED BY THE "OCEAN SURFACE CURRENT SIMULATOR"–OSCURS.** **W. James Ingraham, Jr.** (NOAA Fisheries, retired). DriftBusters Co., 720 Camano View Road, Camano Island, WA 98282.

121 10:00 **QUANTITATIVE ANALYSIS OF POPS IN PLASTIC DEBRIS IN THE OCEAN.** **Lorena M. Rios**[1], Urja V. Narayan[1], Gerardo Castillo[1], Charles Moore[2] and Patrick R. Jones[1]. [1]University of the Pacific, Stockton, CA; [2]Algalita Marine Research Foundation, Long Beach, CA.

122 10:20 **INTERNATIONAL PELLET WATCH: GLOBAL MONITORING OF PERSISTENT ORGANIC POLLUTANTS (POPs) BY USING BEACHED PLASTIC RESIN PELLETS.** **H. Takada,** S. Iwasa, S. Endo. Laboratory of Organic Geochemistry (LOG), Institute of Symbiotic Science and Technology, Tokyo University of Agriculture and Technology, Fuchu, Tokyo 183-8509, Japan.

123 1:40 **SHIPS FOR SCRAP AT ALANG-SOSIYA: LOOMING OF SMALL PLASTICS IN MARINE SEDIMENTS.** M. Srinivasa Reddy, S. Bhasha, S. Adimurthy and **G. Ramachandraiah.*** Central Salt and Marine Chemicals Research Institute, Gijubhai Badheka Marg, Bhavnagar 364 002, Gujarat, India.

124 2:00 **WHAT THE PLASTIC INDUSTRY MUST DO IF WE ARE TO KEEP PLASTIC OUT OF MARINE DEBRIS AND GET TO ZERO WASTE.** **R.V. Anthony.** Richard Anthony Associates, Zero Waste Management, San Diego California 92109.

Saturday, May 13, 2006
Location: Seaver Undergraduate Campus, KSC 130

Session: Fresh Water Vertebrates

Chair: Jim Edmundson, California Trout, Inc.

125 9:00 **LAMPREYS SOUTH OF POINT CONCEPTION AND PERSPECTIVES FROM THE NORTH.** **S.B. Reid** and D. Goodman. Western Fishes, 2045 East Main, Ashland, OR, 97520; U.S. Fish and Wildlife, 1655 Heindon Road, Arcata, CA, 95521.

126 9:20 **THERMAL ECOLOGY OF STEELHEAD IN A WARM-WATER ENVIRONMENT.** **A.P. Spina.** National Marine Fisheries Service, 501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802.

127 9:40 **SOUTHERN CALIFORNIA STEELHEAD: WHERE AND WHAT ARE THEY?** **Mark H. Capelli.** National Marine Fisheries Service, Protected Resources Division, Santa Barbara, CA.

128 10:00 **HABITAT EVALUATION FOR SOUTHERN POPULATIONS OF STEELHEAD TROUT, *ONCORHYNCHUS MYKISS.*** **Sabrina L. Drill**, University of California Cooperative Extension, 4800 E. Cesar Chavez Ave., Los Angeles, CA 90022. Mark Abramson, Heal the Bay, 1444 9th Street Santa Monica, CA 90401. Michelle Bates, TetraTech Inc., 4213 State St., Santa Barbara, CA, 93101. Rosi Dagit, RCD of the Santa Monica Mountains, 122 N. Topanga Bl., Topanga, CA, 90290. Jim Edmonson, California Trout, Inc., 5436 Westview Court, Westlake Village, CA 91362. Elise Kelley, UC Santa Barbara, 619 Empire Ave., Ventura, CA 93003. John O'Brien, California Dept. of Fish and Game, 4665 Lampson Ave. C, Los Alamaitos, CA 90720. Matt Stoecker, Stoecker Ecological, 135 Campo, Portola Valley, CA 94028. Scott Volan, Cachuma Conservation and Release Board, 3301 Laurel Canyon Rd., Santa Barabara, CA 93105.

129 10:20 **SURVIVAL ON THE EDGE: THE PLIGHT OF THE SAN MATEO CREEK SOUTHERN STEELHEAD.** **T.E. Hovey.** Native Fisheries Monitoring Program, California Department of Fish and Game, Santa Clarita, CA 91390.

Chair: Glen Stewart, California State Polytechnic University, Pomona

130 1:40 **STATUS OF THE THREESPINE STICKLEBACK IN SOUTHERN CALIFORNIA.** **T.R. Haglund** and J.N. Baskin. Biological Sciences Department, Cal Poly Pomona University, 3801 W. Temple Ave., Pomona, CA 91768, and San Marino Environmental Associates, 560 South Greenwood Ave., San Marino, CA 91108.

131 2:00 **UPDATE ON *RANA MUSCOSA* IN SOUTHERN CALIFORNIA.**
R.N. Fisher, A.R. Backlin, **C.J. Hitchcock**, and S.A. Hathaway. USGS Western Ecological Research Center, San Diego Field Station, San Diego, CA.

132 2:20 **AN UPDATE: ECOLOGY, STATUS, AND CONSERVATION OF THE WESTERN SPADEFOOT TOAD, *SPEA HAMMONDII.*** **Edward L. Ervin**. Merkel and Associates, 5434 Ruffin Road, San Diego, CA 02123.

133 2:40 **STATUS OF THE CALIFORNIA RED-LEGGED FROG (*RANA DRAYTONII*) IN SOUTHERN CALIFORNIA.** **Norman J. Scott**. U.S. Geological Survey—Retired, Creston, California 93432.

134 3:20 **CONSERVATION IMPLICATIONS OF INTRODUCED AMPHIBIAN SPECIES IN SOUTHERN CALIFORNIA: INSATIABLE PREDATORS OR PLENTIFUL PREY.**
Edward L Ervin. Merkel & Associates, Inc. 5434 Ruffin Road, San Diego, CA 02123.

135 E 3:40 **A PLACE-SPECIFIC EDUCATION PROGRAM TO INCREASE AWARENESS OF INTRODUCED STREAM PREDATORS AND THEIR ROLE IN NATIVE AMPHIBIAN DECLINE.** L.H. Jones, T.S. Watters, S.D. Dudley, G.J. Van Dragt, R.V. Van Dragt, and L.B. Kats. Pepperdine University, Natural Science Division, Malibu, CA, 90263.

136 4:00 **GROWTH AND DEMOGRAPHY OF WESTERN POND TURTLES AT VANDENBERG AIR FORCE BASE, CALIFORNIA.** D.J. Germano, Department of Biology, California State University, Bakersfield, CA 93311-1022. G.B. Rathbun, Department of Ornithology and Mammalogy, California Academy of Sciences, Golden Gate Park, San Francisco, ℅ P.O. Box 202, Cambria, CA 93428.

137 4:20 **THE GARTER SNAKES OF SOUTHERN CALIFORNIA.** G.R. Stewart. California State Polytechnic University, Pomona, Biological Sciences Department, Pomona, CA, 91768.

138 4:40 **GENETIC STRUCTURE IN SOUTHERN CALIFORNIA COASTAL STREAM VERTEBRATES: SANTA ANA SPECKLED DACE, THREESPINE STICKLEBACK, AND CALIFORNIA TREE FROG.** A.E. Metcalf, Dept. of Biology California State University, San Bernardino 92407. I. Phillipsen, Dept. of Zoology, Oregon State University, Corvallis, 97331.

GROUP/PANEL DISCUSSION AS TIME ALLOWS

This symposium grew out of discussions in the Southern California Native Freshwater Fauna Working Group. This is an informal group of individual biologists that meets several times per year at Cal Poly University Pomona to discuss issues relating to the freshwater fauna of Southern California. Its goal is to promote the understanding and long term survival of the Southern California freshwater fauna in its natural habitat.

Saturday, May 13, 2006
Location: Seaver Undergraduate Campus, AC 245

Session: Endocrine Disruptor Compounds in the Southern California Bight

Chair: Daniel Schlenk, U.C. Riverside

143 9:00 **STRESS AND CONSEQUENCES IN THE URBAN OCEAN–ENVIRONMENTAL ENDOCRINOLOGY OF MARINE FISHES OF THE SOUTHERN CALIFORNIA BIGHT.** K.M. Kelley[1], J.A. Reyes[1], J.E. Kalman[1,2], A.W. Hamilton[1], M.M. Galima[1], K. Sak[1], C.G. Lowe[1] and J.L. Armstrong[2]. [1]Environmental Endocrinology Lab, Dept. of Biological Sciences, California State University, Long Beach, Long Beach, CA 90840; [2]Environmental Assessment Division, Orange County Sanitation District (OCSD), Fountain Valley, CA, 92708.

144 9:20 **EVALUATION OF RELATIONSHIPS BETWEEN REPRODUCTIVE METRICS, GENDER AND VITELLOGENIN EXPRESSION IN DEMERSAL FLATFISH COLLECTED NEAR THE MUNICIPAL WASTEWATER OUTFALL OF ORANGE COUNTY, CALIFORNIA, USA.** Rempel, Mary Ann[1]*; Reyes, Jesus[2]; Steinert, Scott[3]; Hwang, Wendy[1]; Armstrong, Jeff[4]; Sakamoto, Ken[4]; Kelley, Kevin[2]; Schlenk, Daniel[1]. [1]University of California Riverside, Riverside, CA; [2]California State University of Long Beach, Long Beach, CA; [3]CSC Biomarker Laboratory, San Diego, CA; [4]Orange County Sanitation District, Fountain Valley, CA.

145 9:40 **SEASONAL EVALUATION OF REPRODUCTIVE STATUS AND EXPOSURE TO ENVIRONMENTAL ESTROGENS IN HORNYHEAD TURBOT AT THE MUNICIPAL WASTEWATER OUTFALL OF ORANGE COUNTY.** Xin Deng, Mary Ann Rempel and Daniel Schlenk. Department of Environmental Sciences, University of California, Riverside, CA 92507.

146 10:00 **REGION-ASSOCIATED DISRUPTION OF FLATFISH ENDOCRINE SYSTEMS–STUDIES IN THE SOUTHERN CALIFORNIA BIGHT.** **Jesus A. Reyes,** Dawn M. Petschauer, and Kevin M. Kelley. Environmental Endocrinology Lab, Marine Biology Program, California State University, Long Beach, Long Beach, CA 90840.

147 10:20 ***IN VIVO* BIOASSAY GUIDED FRACTIONATION OF MARINE SEDIMENT EXTRACTS FROM THE SOUTHERN CALIFORNIA BIGHT FOR ESTROGENIC ACTIVITY.** **D. Schlenk**[1]*, Y. Sapozhnikova[1], M. Irwin[1], L. Xie[1], W. Hwang[1], S. Reddy[2], B.J. Brownawell[2], J. Armstrong[3], M. Kelly[4], D.E. Montagne[5], E.P. Kolodziej[6], D. Sedlak[6], S. Snyder[7]. [1]Department of Environmental Sciences, University of California, Riverside, CA, USA; [2]Marine Sciences Research Center, Stony Brook University, Stony Brook, New York, USA; [3]Ocean Monitoring, Orange County Sanitation District, Fountain Valley, CA USA; [4]Ocean Monitoring, City of San Diego, San Diego, CA, USA; [5]Ocean Monitoring & Research Group, Los Angeles County Sanitation Districts, Whittier, CA, USA; [6]Department of Civil and Environmental Engineering, University of California, Berkeley; [7]Water Quality Research and Development Division, Southern Nevada Water Authority, Las Vegas, Nevada.

Saturday, May 13, 2006
Location: Seaver Undergraduate Campus, AC 245

Plenary Session: Palos Verdes Shelf Remediation and Restoration

Moderator: Joseph Gully, Los Angeles County Sanitation Districts

148 **HISTORICAL AND LEGAL OVERVIEW.** **John Saurenman.** California Department of Justice.

A discussion of the history of DDT/PCB contamination on the shelf, the legal battles which were settled for 140 M dollars, and how that money was divided among the various remediation/restoration entities.

149 **INSTITUTIONAL CONTROLS.** **Sharon Lin.** Public Outreach and Education, USEPA Region 9.

The institutional control (IC) program is focused on the protection of human populations at risk to DDT and PCB exposure from eating contaminated fish. The ICs program consists of public outreach to at risk populations, fish contamination monitoring, and white croaker commercial catch ban and bag limit enforcement. The ICs program has bee in full implementation phase since 2002. The stakeholders of the PV Shelf project completed a series of workshops to develop a revised strategic plan for the ICs components in Fall 2005. The presenter will show a video describing the ICs program with an emphasis on the public outreach component of the program, the Fish Contamination Education Collaborative. The presenter will give a status update on the program and discuss any related subjects that are of interest to the meeting attendees.

150 **RESOURCE RESTORATION.** **Dave Witting.** Montrose Settlement Restoration Program.

Provide an overview of the recently released final plan for restoring natural resource injuries caused by DDTs and PCBs discharged onto the Palos Verdes shelf. The plan details how they intend to restore fishing services, fish habitat, bald eagles, peregrine falcons, and seabirds to the Southern California Bight. The presentation will describe the status of a comprehensive fish contamination study for DDTs, PCBs and mercury and how results from this study will guide resource restoration projects.

151 **SITE REMEDIATION.** **Carmen White.** Superfund Division, USEPA Region 9.

Provide an overview of the studies conducted regarding characterization of the site and a discussion of the options being considered for site remediation. EPA is getting ready to release its remedial investigation report, which will show why there are no easy answers to cleaning up Palos Verdes Shelf.

Saturday, May 13, 2006
Location: Seaver Undergraduate Campus, AC 245

Session: Environmental Pollution

Chair: Lan Wiborg, City of San Diego

156 2:00 **USE OF *IN SITU* HATCHBOX STUDIES TO EVALUATE WATER QUALITY EFFECTS.** Howard Bailey[1]*, Ben Chalmers[2], and James Elphick[1]. [1]Nautilus Environmental, San Diego, CA; [2]Myra Falls Mine, Campbell River, British Columbia.

157 2:20 **EVALUATION OF IMPACTS AND BENEFITS ASSOCIATED WITH DISCHARGE OF TREATED EFFLUENT TO THE SANTA CLARA RIVER ESTUARY.** Bailey, Howard C.[1]; Stransky, Chris[1]; Kamman, Greg[2]; and Pfeifer, Dan[3]. [1]Nautilus Environmental, San Diego, CA; [2]Kamman Hydrology and Engineering, Inc., San Rafael, CA; [3]City of San Buenaventura, Ventura, CA.

158 2:40 **CHARACTERIZATION OF CHOLINESTERASES FROM TWO DEMERSAL FLATFISH COLLECTED NEAR A MUNICIPAL WASTEWATER OUTFALL IN SOUTHERN CALIFORNIA.** Gabriela Rodriguez-Fuentes[1]*, Daniel Schlenk[1] and Jeff Armstrong[2]. [1]University of California Riverside, Riverside CA; [2]OCSD, Fountain Valley, CA.

159 3:20 **TOXICITY IDENTIFICATION EVALUATION (TIE) CASE STUDY OF A GEOTHERMAL ELECTRIC PLANT LOCATED IN SOUTHERN CALIFORNIA.** John Rudolph, Chris Stransky, and Howard Bailey. Nautilus Environmental, San Diego, CA 92121.

160 3:40 **EXTENT AND MAGNITUDE OF COPPER CONTAMINATION IN MARINAS OF THE SAN DIEGO REGION.** Kenneth Schiff*, Jeff Brown and Dario Diehl. Southern California Coastal Water Research Project, Westminster, CA.

Saturday, May 13, 2006
Location: Seaver Undergraduate Campus, AC 210

Session: Research Training Program–Session 1

Chair: Richard Schwartz, RTP

161 9:00 **PHYSICAL ASPECTS OF SOUTHERN CALIFORNIA BEACHES AND HOW PEOPLE PERCEIVE THEM: CONSIDERATIONS FOR BEACH NOURISHMENT PLANNING.** Scott H. Grove. Sonora High School, La Habra, CA.

162 9:20 **TRANSPLANTED XY SPERMATOGONIA STEM CELLS COLONIZE IN THE SEMINIFEROUS TUBULES OF XXY MICE.** B. Chuck, Calif. Inst. of Math and Science. Y. Lue, Department of Medicine, LABiomed at Harbor-UCLA Medical Center, Torrance, CA 90502.

163 9:40 **COUNTING THE MICROINFARCT(S) IN SECTION R-19 OF A HUMAN BRAIN.** Huynh, Tommy. Alhambra H.S., and Neuroscience Method Research Group, University of Southern California, Department of Neurology, Los Angeles, CA, 90242.

164 10:00 **MUTAGENIC ANALYSIS OF THE CYTOCHROME P450 14α-DEMETHYLASE (CkCyp51p) TO AZOLE RESISTANCE IN *CANDIDA KRUSEI*.** Da Eun Im, Calif. Inst. of Math and Science, Trang Phan, Hyunsook Park. Scott G. Filler, Division of Infectious Diseases, Department of Medicine, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA 90502.

165 10:20 **FACTORS AFFECTING BALANCE AND PCP DISORDERS: THE INFLUENCE OF NATURAL STIMULI IN MICE UTRICLES YEAR 2.** **D.E. Lluncor**, Palos Verdes Peninsula High School. David Geffen, School of Medicine at UCLA, Division of Neurobiology Head and Neck Surgery Laboratory of Vestibular/Sensory Neurobiology, Los Angeles, CA 90095.

Chair: Martha Schwartz, RTP

166 1:40 **EFFECTS OF STRESS AND EXERCISE IN BRAIN-DERIVED NEUROTROPHIC FACTOR EXPRESSION.** H.T. Luu, Alhambra High School. M.J. Chen and A. Russo-Neustadt, Department of Biological Sciences, California State University, Los Angeles, CA, 90032.

184 2:00 **MAKING CAMKIIδA BY THE ADENOVIRUS SYSTEM.** Tea, Nicky-Chai, Yan Bai. University of Southern California, Institute for Genetic Medicine, Los Angeles, 90033.

185 2:20 **PHOTOOXIDATION OF COBALT-BOUND THIOLATO LIGANDS.** **May Chow**, Alhambra High School. Mentor:

169 2:40 **BIOARTIFICIAL HEART TISSUE: AN ELECTROACTIVE POLYMER FOR CARDIAC PATCHES.** Karis R. Tang-Quan, Palos Verdes Peninsula High School, Rolling Hills Estates, CA 90274. Mentor: Dr. Ben Wu, UCLA, Department of Bioengineering, Los Angeles, CA 90095.

170 3:20 **MYOSTATIN EFFECT ON BODY COMPOSITION IN GENETICALY MODIFIED MICE.** D. Wu, Cypress H.S. B.D. Harvey, S. Porszasz-Reisz, College of Science and Health, Charles R. Drew University of Medicine and Science, 1731 E. 120th Street, Los Angeles, CA 90059.

171 3:40 **HEAT SHOCK PROTEIN 70 (HSP70) EXPRESSION IN MULTIPLE SCLEROSIS.** Young, Amy, Alhambra H.S. Multiple Sclerosis Research Group, University of Southern California, Keck School of Medicine, McKibben Hall, 1333 San Pablo Street, Los Angeles, CA, 90033.

173 4:00 **EXPOSURE TO HYPEROXIA DURING PERINATAL PERIOD DISRUPTS SPECIFIC PULMONARY ALVEOLAR EPITHELIAL-MESENCHYMAL SIGNALING PATHWAYS.** Sanyl Kabre, Sharon Sugano, Dr. John S. Torday, Dr. Virender, K. Rehan. Dept. of Pediatrics and Obstetrics & Gynecology, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA.

Saturday, May 13, 2006
Location: Seaver Undergraduate Campus, AC 205

Session: Research Training Program–Session 2

Chair: Mrs Kathy Phelan

174 9:00 **INVESTIGATING PROTOCOLS FOR *HALIOTIS RUFESCENS* EGG CRYOPRESERVATION.** **Julie A. Guerin**. Cabrillo Marine Aquarium, San Pedro, CA 90731; Palos Verdes Peninsula High School, Rolling Hills Estates, CA 90274.

175 9:20 **MEASURING THE PERCEIVED PREDATION RISKS IN HOUSE FINCHES IN DIFFERENT HABITAT TYPES.** Singh, Deepak H., Whitney H.S. Fernandez-Juricic, Esteban, and Valcarcel, Anna, Department of Biological Sciences, California State University, Long Beach, Long Beach, CA 90840-3702.

176 9:40 **EFFECTS OF TIDAL FLUCTUATIONS ON THE AVAILABILITY OF NITROGEN COMPOUNDS IN THE LOS ANGELES HARBOR.** Sanjit Datta. Palos Verdes Peninsula H.S., Cabrillo Marine Aquarium, 3720 Stephen White Drive, San Pedro, CA 90731.

177 10:00 **A STUDY OF FECAL INDICATOR BACTERIA (FIB) IN THE BALLONA WETLANDS AND DEL REY LAGOON, LOS ANGELES COUNTY, CALIFORNIA.** S. Yanamadala[1] and John H. Dorsey[2]. [1]Chadwick High School, 26800 S. Academy Drive, Palos Verdes Peninsula, CA, 90274; [2]Loyola Marymount University, Department of Natural Sciences, Los Angeles, CA, 90045.

178 10:20 **ANALYSIS OF PHYSICAL PROPERTIES OF LINEAR ACCELERATORS USING MATHEMATICAL AND EXPERIMENTAL METHODS.** J. Luo, Alhambra H.S. O.O. Bernal, California State University Los Angeles, Department of Physics, Los Angeles, California, 90032.

Chair: John Dorsey, LMU

179 1:40 **THE NEW AND INNOVATIVE OPTIC ACCELEROMETER SENSOR.** **R. Purasinghe**, Alhambra H.S. Dr. Feng and Dr. Kim, University of California Irvine, Department of Structural Engineering, Irvine, CA, 92697.

180 2:00 **ATAXIA TELANGIECTASIA AND DOSAGES OF BLEOMYCIN.** **Sunghye Kim**, Calif. Inst of Math and Science. Helen Chun, California State University of Dominguez Hills, Department of Biology, Carson, CA 90747.

186 2:20 **THE EFFECTS OF THE HSR-OMEGA GENE IN DROSOPHILA MELANOGASTER.** **William Martin**. Benzer Lab, California Institute of Technology, Pasadena, CA, 91125.

182 2:40 **PERCENT METHYLATION AND ITS RELATIONSHIP WITH AGING.** **Shelly Tat**, Alhambra H.S. Dr. Shibata, USC Norris Cancer Center, 1441 Eastlake Ave., Los Angeles, CA 90033, Topping Tower 6410.

183 3:20 **COMPUTATIONAL ANALYSIS OF GRAINYHEAD-LIKE EPITHELIAL TRANSACTIVATOR (GET1) REGULATED GENES.** **Madhvi Venkatesh**, University H.S. Ambica Bhandari and Bogi Andersen, University of California, Department of Biological Chemistry, Irvine, CA, 92697.

187 3:40 **FUNCTIONAL ANALYSIS OF THE MBNL3 PROTEIN.** **Dan Qing Yan**, University of Southern California, Institute of Genetic Medicine, Los Angeles, CA 90033.

ABSTRACTS–Program Order

1 STANDARDIZED METHODS FOR MONITORING PLASTIC IN THE MARINE ENVIRONMENT

Zellers, Ann. Algalita Marine Research Foundation 1021 N Harbor Dr. Redondo Beach, CA 90277

As marine debris has become the focus of an increasing number of studies since the 1970's it has been found that this debris has a ubiquitous presence in almost every marine niche. At a 2005 conference titled "Plastic Debris Rivers to Sea" scientists from around the world confirmed the overwhelming presence of plastic in the marine environment. However, as a global problem, the quantification of plastic marine debris is too large for any company or government agency to handle alone.

In order to facilitate future analyses AMRF would like to propose a standardization of the data collection process, including guidelines for exchange of data and findings among interested parties. We propose such a "strawman" protocol for sorting plastic pollutants in water samples and in beach sand samples, based upon our experience over the last 7 years. Our suggested protocol addresses separating samples into their organic and non organic components, establishing size classes, color characteristics, material characteristics, etc. In the event pertinent data is acquired, either as a specific objective or as a by-product of other data collections in the field, we believe use of such a protocol would benefit a global body of researchers on an economical and timely basis. We would like to encourage the coordination and discussion of the use of such a standardized protocol.

2 PLASTIC DEBRIS, RIVERS TO SEA: AN OVERVIEW OF THE PROP 13 FUNDED PROJECT "ASSESS AND REDUCE SOURCES OF PLASTIC AND TRASH IN URBAN AND COASTAL WATERS"

C.J. Moore, **G.L. Lattin**, A.F. Zellers. Algalita Marine Research Foundation, 148 N. Marina Drive, Long Beach, CA 90803

Policies in California have been established to restrict trash and plastic greater than 5 mm in size through the process of regulating Total Maximum Daily Loads (TMDLs). In order to quantify debris not subject to regulation by TMDLS, a study was conducted by the Algalita Marine Research Foundation and the California Coastal Commission with funding by the State Water Resources Control Board to analyze plastic trash between 1 and 5mm in size as well as that >5mm from two Southern California Rivers; the Los Angeles River and the San Gabriel River. One of the most notable components of the plastic debris studied that is less than 5 mm was pre-production pellets. The results will be presented from the three areas of interest in the study: (1) Plastic industrial sites, (2) Mass Emission sites, and (3) Analysis of plastic particles for the sorbtion of POPs (Persistent Organic Pollutants). Plastic industry sites were studied to determine if voluntary Best Management Practices (BMP) had any affect on the amount of plastic debris found at the facility. The industrial site grounds where there was a potential for any runoff to reach the storm drain system and the nearest storm drain to each facility were sampled both pre and post BMP implementation and during both wet and dry weather conditions. Three mass emission stations; one on the Los Angeles River, and two on the San Gabirel River, were sampled using a Manta Trawl, Hand Nets, and a Streambed Sampler. Plastic particles and pre-production pellets between one and five millimeters in diameter were sampled from river banks and beaches in the Los Angeles and San Gabriel Rivers' Watersheds, and subjected to Gas Chromatography-Mass Spectrometry (GCMS) analysis.

3 UNRESOLVED TECHNICAL ISSUES IN PLASTICS IN THE MARINE ENVIRONMENT

Tony Andrady PhD. Senior Research Scientist, Research Triangle Institute, Durham, NC 27709

Despite the widespread interest in plastics as a persistent pollutant in the world's oceans, little is reported in the technical literature on the fate of the material in marine environments. The effectiveness of the environmental degradation mechanisms when operating under marine conditions has not been studied in sufficient detail.

This presentation will review what is known about the routes for degradation of plastics debris in the marine environment, the fate of common plastics likely to find their way into the world's oceans, and the impact of the partially-degraded plastic materials on marine life. Particular emphasis will be placed on the effect of microparticulate plastics on the marine ecosystem. While little is known on their interaction with marine life, the potential hazards associated with the material can be serious. There is an urgent need to generate the necessary data to either support of disprove these potential routes of damage to the marine ecosystem, the food web, and ultimately the fisheries resource.

4 MICROBIAL ACTIVTIES IN THE DEEP SEA

C.O. Wirsen. Woods Hole Oceanographic Institution, Biology Department Woods Hole, MA 02543

The deep sea is the largest continuous biosphere on earth. The understanding of microbial processes and biodegradation activities occurring in the deep sea is fundamental to questions of both a basic and applied nature. Over the past 30 years our research has concentrated on studying microbial populations both *in situ* and as pure cultures of isolated microbes. While metabolic processes are significantly reduced (several fold to more than an order of magnitude) in the deep sea compared to surface waters due to cold temperatures and high hydrostatic pressures, many microbes (psychrophilic and barophilic) found in this environment are specifically adapted to function well under these conditions. The deep sea is an oligotrophic or nutrient poor environment and it has been one of our approaches to study the growth of these populations and specific microbes using a variety of high pressure sampling and incubation equipment. A high degree of pressure adaptation can be found in organisms isolated from both nutrient rich (e.g. intestinal tracts) and nutrient poor environments in the deep sea. Certain biopolymers such as polyhydroxyalkanoates (PHA) and polycaprolactone (PCL) as potential substitutes for conventional plastics have been shown to biodegrade in the marine environment, albeit faster under optimum laboratory conditions in comparison to open marine conditions. If these materials are to be discharge into the marine environment along with conventional organic wastes, their biodegradability needs to be demonstrated and the discharge amounts should not follow previous examples of concentrated discharge in any one designated area (e.g. organic sludge disposal sites).

5 BIODEGRADATION TESTING METHODS FOR POLYMERS IN THE MARINE ENVIRONMENT

J.A. Ratto, R. Stote, J. Herbert, **C. Thellen,** U.S. Army Natick Soldier Center, Natick, MA. C. Wirsen, Woods Hole Oceanographic Institution, Woods Hole, MA

The U.S. Army Natick Soldier Center (NSC) and Woods Hole Oceanographic Institution have done extensive research supported by the Naval Inventory Control Point (NAVICP), to evaluate biodegradability and toxicity of polymers in the marine environment. The goal for the U.S. Navy is to replace some of the conventional plastic used on board ship with biodegradable plastics, therefore, diverting some of the current plastic waste to the food/paper category so it can be disposed of in the marine environment. A laboratory respirometry test, ASTM-6691-01, "Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials in the Marine Environment by a Defined Microbial Consortium" was developed to measure percent biodegradation as a function of time, using a consortium of marine microorganisms in an aerobic marine environment. Some of the biodegradable polymers tested to date exhibit acceptable biodegradation in comparison to some paper products currently being discharged into the ocean. ASTM D7081-05, "Standard Specification for Non-Floating Biodegradable Plastics in the Marine Environment" was also established to define plastic biodegradability in the marine environment. Closed (static) and open (dynamic) incubations, as well as coastal and deep sea mooring incubations can also be performed in conjunction with the ASTM method to evaluate levels of biodegradation. Data for each type of test method will be presented. Environmental Protection Agency approved toxicity tests have also been performed for a variety of polymers and none of the samples evaluated have shown any toxicity under the test conditions. Additionally, these biodegradable materials could be nutrient sources for microbes, plants and animals in the ocean.

6 SEABIRDS AS INDICATORS OF PLASTIC POLLUTION IN THE NORTH PACIFIC

D. Hyrenbach, Duke University Marine Laboratory, Beaufort, NC 28516. **C. Keiper**, Oikonos Ecosystem Knowledge P.O. Box 979, Bolinas, CA 94924. H. Nevins, BeachCOMBERS, Moss Landing Marine Laboratories, Moss Landing, CA 95039 and Oikonos Ecosystem Knowledge. M. Hester, Oikonos Ecosystem Knowledge. C. Moore, Alalita Marine Research Foundation, 148 N Marina Drive, Long Beach, CA 90803. J. Harvey, BeachCOMBERS, Moss Landing Marine Laboratories, Moss Landing, CA 95039

A variety of surface feeding seabirds that feed on fish, squid and zooplankton incidentally ingest floating plastic debris. Adults often feed these items to their chicks, with potentially detrimental effects on their growth and survival. Because far-ranging seabirds sample vast areas of the ocean, they can provide useful information about the incidence and distribution of marine plastic pollution. In the North Pacific Ocean, several surface-feeding seabirds, including the Laysan Albatross (*Phoebastria immutabilis*), Black-footed Albatross (*Phoebastria nigripes*), Northern Fulmars (*Fulmarus glacialis*) and Red Phalaropes (*Phalaropus fulicarius*) are especially susceptible to plastic ingestion. We review the literature for known impacts of plastic ingestion on selected North Pacific seabirds and identify several factors which contribute to increasing their susceptibility, including foraging mode, habitat, and body size. To illustrate the use of seabirds as bio-indicators of marine pollution, we present results of two studies: (1) plastic ingestion by beach-cast Northern Fulmars collected in California during 2003–2004 and (2) overlap of satellite-tracked Black-footed albatross (July–September 2004–2005) with the "Eastern Garbage Patch", a major area of debris accumulation in the Eastern North Pacific. The harmful effects of plastic ingestion, including the death of chicks and higher pollutant loads in adults, may further jeopardize the survival of the Black-footed Albatross, a species listed as endangered due to other human related sources of mortality associated with by-catch from longline fishing. Because plastic debris ingestion is a pervasive and increasing problem for seabirds, the study and remediation of marine pollution has important implications for global conservation.

7 DISTRIBUTION OF ANTHROPOGENIC AND NATURAL DEBRIS ON THE MAINLAND SHELF OF THE SOUTHERN CALIFORNIA BIGHT

S.L. Moore[1] and S.M. Walther[2]. [1]Southern California Coastal Water Research Project, Westminster, CA, 92683; [2]Los Angeles County Sanitation Districts, Carson, CA 90745

Many studies have been conducted to quantify debris found along beaches; however, little information has been compiled about debris found on the seafloor. Here we summarize three trawl studies done in the Southern California Bight in the summers of 1994, 1998, and 2003 and one trawl study done quarterly since 1996 off the Palos Verdes Peninsula. For each of these studies debris was categorized, counted, and weighed. For the summer studies, natural and anthropogenic debris was widespread on the mainland shelf but was generally found in small amounts at any given site. Anthropogenic debris was most common in the southern and central regions, on the outer shelf and upper shelf, and in areas near publicly owned treatment works (POTWs). Plastic was the most common anthropogenic debris item found in both summer and quarterly trawls followed by metal debris and cans. Quarterly trawls show that anthropogenic debris is most commonly collected during the winter and least during the fall. The amount of debris collected during winter trawls is dependent upon the amount of rainfall for any given year. The deeper distribution of terrestrial debris for both summer and quarterly trawls, suggests that most of the anthropogenic debris in these areas may come from terrestrial sources.

8 INTEGRATING CURRENT SCIENCE INTO SCHOOL CIRRICULUMS

Marcus Eriksen, Algalita Marine Research Foundation, 148 N. Marina Drive, Long Beach, CA 90803. **Amy Frame**, Environmental Charter High School, 4234 W. 147th St., Lawndale, CA 90260

High school textbooks are typically the last place current scientific knowledge is published. Educators that rely on textbooks as a primary resource to integrate science into the classroom may lose opportunities to interact with scientists and involve students in ongoing research. A partnership between the Algalita Marine Research Foundation (AMRF) and the Environmental Charter High School in Lawndale, California, provides a model for integration of marine science into school curriculum. AMRF investigates the impact of marine debris on watersheds and the marine environment. Since

2004, under the direction of AMRF staff, the inner-city high school students have investigated plastic debris on California beaches, wetlands, and inside seabirds. Results for students include greater interest and participation in science activities, relevance to their daily lives, and increased community activism. The success of this partnership relies on four characteristics: adequate funding, proximity between school and research lab, and receptivity of teachers and scientists. Several suggestions to create these partnerships include: (1) write both science and education components into grants, (2) create low-level internships for teachers or students, and (3) make student data significant to current research or community issues.

9 HEALTH EFFECTS OF PLASTICS: AN OVERVIEW

S.S. Mosko. Earth Resource Foundation, Costa Mesa, CA 92627

Numerous potential health risks stemming from petroleum-derived plastics have come to light in the last decade based on a wealth of animal and human studies. Depending on the type of resin in question, plastics can represent health threats at all three stages in their life cycle: synthesis, period of use and disposal. Either the actual building blocks of the resins or various additives later "mixed-in" (i.e. non-covalently bonded, allowing migration to occur) can be the focus of concern. An overview is presented of the literature on toxicities (endocrine disruption, developmental toxicity, carcinogenicity) associated with four common plastics.

a) Polyvinyl chloride
  —vinyl chloride monomer, a known carcinogen, is released during manufacture.
  —endocrine disrupting phthalate esters are added in large quantities as plasticizers.
  —toxic heavy metals additives serve as heat/UV light stabilizers.
  —dioxins are produced during manufacture and incineration.
b) Polycarbonates
  —the building block is bisphenol-A, a synthetic estrogen.
c) Non-stick (e.g. Teflon) coatings
  —perfluorooctanoate (PFOA or C-8), a known carcinogen that is used and produced during manufacture, is building up in human tissues.
  —dangerous vapors and particulates are released at high cooking temperatures.
d) Polystyrene
  —polymerization is never complete, allowing leaching of the carcinogenic styrene monomer.
  —flame retardants (polybrominated diphenyl ethers or PBDEs), known to act as carcinogens and developmental toxins, can be present in high concentrations.

10 CLUES IN A MATCHMAKING MYSTERY: LINKING THE SEXES OF GNATHIID ISOPODS

L. Haney. Los Angeles County Sanitation Districts, Marine Biology Laboratory, Carson, CA, 90745

Currently, 10 genera and 172 species of gnathiid isopods are recognized worldwide. These animals are widely distributed in marine habitats. They are found as free-living adults in benthic environments and as parasitic larvae on many teleost and elasmobranch fishes. In most instances, species designations are based solely on the morphology of the adult male; generally, the female and larval stages are unresolved. Male gnathiids have specific characters that help distinguish species rather easily. Conversely, females share similar gross morphologies and lack obvious defining characters. The same is true for larval forms. For this reason, identifications of females and larval forms are typically left at Gnathiidae sp. This leads to a loss of reported diversity, numerical abundance, and ecological data for this family of isopods. An extensive review of gnathiid morphology has provided clues to matching the males and females of particular species in the Northeast Pacific (NEP). The NEP fauna includes two genera and 12 species, four of which are new to science. While specimens of all forms of each species have not been attainable, sufficient material was found to make trends within the family clearer. A suite of morphological characters, used in combination, exhibit high fidelity between males and females. Based on these patterns and material available, it was possible to link the sexes for roughly half of the species. Using similar character combinations may provide useful clues to identifying the remaining NEP species couplets, once material for those are encountered.

11 HOLOTHUROID AND ECHINOID AGGREGATE BEHAVIOR ON THE EASTERN PACIFIC ABYSSAL PLAIN

K.D. Trego. Nautilus Oceanic Institute, La Jolla, CA 92037

Trawl samples and benthic imagery indicate that certain holothurians (*Abyssocucumis abyssorum, Oneirophanta mutabilis, Psychropotes longicauda, Scotoplanes globosa*) and echinoids (*Aporocidaris milleri, Cystechinus loveni, Cystocrepis setigera, Echinocrepis rostrata,* Echinothuridae) are found on the abyssal plain of southern California and Baja California. Abyssal trawl samples rarely contain large numbers of these species (e.g. *A. abyssorum, A. milleri, E. rostrata*) and may indicate the presence of aggregate numbers. Benthic imagery indicates that aggregate behavior of these echinoderms may take place on the abyssal plain. Holothurian and echinoid aggregations in response to food supply (kelp falls, detritus deposits, cold seeps, whale falls) have been seen in shallower depths. Kelp falls on the abyssal plain are rare and consist only of fragments. Detritus deposits on the abyssal plain have been seen to attract the holothuroid *A. abyssorum* and the echinoid *E. rostrata.* The holothuroid *S. globosa* has been seen at a cold seep location in the Peru-Chile Trench. Benthic ecologist Linda Kuhnz of the Monterey Bay Aquarium Research Institute reported the holothuroid *S. globosa* and the echinoid *C. setigera* were found at the whale fall in Monterey Canyon at a depth of 2890 meters. The holothuroid *P. longicauda* may be found in the vicinity of hydrothermal activity. A yellow color form of *P. longicauda* has been found in the Clarion Clipperton Fracture Zone at 5000 meters and this modification of the normal purple color may be due to exposure to sulfur in the substrate from a low hydrothermal flow.

12 SCALES OF VARIATION IN SMALL FISH MERCURY CONTENT–INITIAL FINDINGS

A. Jahn, B.K. Greenfield, J.L. Grenier. and S. Shonkoff. San Francisco Estuary Institute

Significant management actions are underway that have the potential to change mercury (Hg) concentrations in fish from San Francisco Bay. There is concern that extensive tidal marsh restoration could increase mercury in the food web. Small fish are a useful tool for monitoring inter-annual changes in methylmercury in aquatic ecosystems. They integrate finer-scale spatial and temporal patterns of methylmercury uptake into the food web, while providing more localized data than large fish. From November through December of 2005, we sampled small fish (Atherinopsidae and Gobiidae) from two basic mobility types (vagile and sedentary) at eight locations in the Estuary. Multiple composite samples of five to ten individuals each were collected at each sampling location, weighed, measured, and sent for whole-body analysis of total mercury concentration. Sampling location and fish size both affected Hg tissue concentration. With these factors accounted for, Mississippi silverside still had higher Hg concentration than other species tested, and silversides at southern sites had more Hg than fish in northern reaches of the bay. Cheekspot goby had higher Hg at Alviso Slough than at other south bay sites, but was not captured in North Bay. In topsmelt, samples from Alviso slough and Eden landing were highest in Hg, and those from Oakland Harbor were lowest, but fish from the most northern site, Benicia, were indistinguishable from those sampled at Newark Slough and Bird Island in the south. Bay goby, the only strictly subtidal species tested, had significantly lower Hg concentration than the intertidal species.

13 DISTRIBUTION AND IMPORTANCE OF AGE-0 ATHERINOPSID FISHES IN SOUTH-CENTRAL SAN FRANCISCO BAY

A. Jahn, C. Ehrler, and M.L. Elliott. Andrew Jahn Consulting, Ukiah, CA, Tenera Environmental, and PRBO Conservation Science

Through 20 years of dropped fish collections at the Alameda Point (San Francisco Bay) least tern colony, atherinopsids combined (but mainly jacksmelt) have comprised > 60% by number and (when measured) biomass. A sampling program using beach seines, purse seines, and neuston nets complemented a four-year study of tern chick provisioning. Fish accepted by chicks were mostly ≤ 83 mm TL and averaged about 15 mm smaller than the collected dropped fish. The median length of fish accepted by newly hatched chicks was about 40 mm. We rarely captured atherinopsids of this size in deep (> 8 m) areas of the bay. Larvae and small juveniles of all three native atherinopsids (jacksmelt, topsmelt, grunion) were captured in highest numbers throughout the summer in the intertidal zone and in two small embayments. The thalweg of San Leandro Bay, bordered by mudflat, produced the highest purse seine catches per unit effort, comparable to the highest densities taken by beach seine. At Crown Beach, the longest sand beach within the known foraging area for terns nesting at Alameda, catch rates of atherinopsids in the tern-diet size range were about 100 times greater at high tide than at low tide. The inferred, periodic movements of these fish appear to be a mechanism to avoid stranding on the adjacent tidal flat. Age-0 jacksmelt lose their affinity for the shoals, becoming ubiquitous over the bay after reaching about 70 mm TL. Their wider distribution and larger size-at-age appears to account for the numerical dominance of jacksmelt in the dropped-fish collections.

14 INVESTIGATION OF THE VIRTUAL ELECTRIC CHARGE EFFECT

Jennifer Nguyen. Milpitas High School, 1285 Escuela Parkway, Milpitas, CA 95035

The purpose of this investigation is to document the behavior and characteristics of a newly observed magnetic effect on charged particles. Based upon the behavior of electrons interacting with the effect, it is termed the Virtual Electric Charge Effect (VECE). Traditionally, the motion of charged particles in magnetic fields is governed by the Lorentz Force and visualized with the Right Hand Rule. Observations showed that the effect occurs under limited conditions and does not follow the Lorentz Force Law. The discovery of this new effect may explain other phenomenon involving magnetism, including the AB effect.

This project used directed testing to evaluate the nature of the Virtual Electric Charge Effect. A particle accelerator was improvised using an Oscilloscope CRT. In addition, magnetic field simulation software was used to validate expected results. Several permanent magnets of varying strength were tested repeatedly to show the effect of the magnet's poles on the motion and shape of the electron beam. The VECE had the North Pole repel electrons away from the pole and the South Pole attract electrons to the pole. The North and South Poles had distinctly opposite effects (i.e. one pole attracts and one repels). Notably, under VECE conditions, the Right Hand Rule demonstration fails when the magnet's pole is against the screen of the oscilloscope. Basically, when the VECE is apparent, electrons are affected by the pole in contrast to the typical demonstrations. Moreover, I discovered that as the strength of the magnet increased, the new effect became more pronounced.

15 EFFECTS OF VERTICAL DISTRIBUTION ON DISPERSAL POTENTIAL OF KELP SPORES

D.K. Cie and M.S. Edwards. San Diego State University, Department of Biology, San Diego, CA 92182

Kelp forests are among the world's most productive ecosystems and serve as a key source of food and shelter for a wide range of species. Presently, the widely accepted theory of kelp propagation is that reproductive spores are passively dispersed along the benthos via advective and diffusive transport. However, it is possible that these spores can also be dispersed vertically towards the surface, encountering stronger unidirectional flow which may allow them to travel away from an existing kelp stand. The aim of this study is to address the effects of vertical distribution on dispersal potential of kelp spores. To address this theory, we developed a novel technique employing a vertical spore profiler (VSP) to collect settled spores at various heights off the substrate. Our preliminary data has shown that in addition to being dispersed within the first meter above the substrate, spores were able to travel as high as 10 meters from the benthos. To our knowledge, this is the first report of its kind. Currently, we are also investigating the effects of irradiance and grazing pressure throughout various levels in the water column. Information gained from this research may help elucidate the methods of vertical dispersal and the recovery of kelp populations, thereby contributing to the proper management of these natural ecosystems, and the understory communities that rely upon them.

16 CHANGES IN LATITUDES, CHANGES IN . . . MORPHOLOGY? STIPE HOLLOWING IN *EISENIA ARBOREA* (PHAEOPHYCEAE)

P.G. Matson and M.S. Edwards. San Diego State University, Department of Biology, San Diego, CA, 92182

Morphological variation is common in kelps (Phaeophyceae, Laminariales) and often results from differences in environmental conditions. Stipe hollowing, in particular, occurs in several kelp species worldwide but to date has been investigated for only a few species and primarily at local scales. Here we describe the patterns of stipe hollowing both within and among populations of *Eisenia arborea* across 800 km of its distribution along the west coast of North America. Our results indicate that there are large latitudinal differences among populations in both the occurrence of stipe hollowing (*i.e.* frequency of hollow stipes within a population) and hollowing extent (*i.e.* length of the hollow cavity relative to stipe length) in *E. arborea* sporophytes. Stipe length varied among our study locations with the most southern population exhibiting the tallest stipes, the most northern population exhibiting the shortest stipes, and the three central populations exhibiting intermediate stipe lengths. The occurrence of stipe hollowing and hollowing extent also varied along a latitudinal gradient, with the more southern populations exhibiting both increased frequencies of hollowing and greater hollowing extents. In fact, while hollowing occurred in almost all (97%) of the sporophytes examined at the most southern location, it was absent in the sporophytes examined at the most northern location. Finally, although stipe hollowing was more common in larger stipes across all locations, due to the overwhelming effect of location on the occurrence of stipe hollowing, stipe length alone is not a suitable predictor when considered across this species range.

17 DELAYED RECOVERY OF GIANT KELP NEAR ITS SOUTHERN RANGE LIMIT IN THE NORTH PACIFIC FOLLOWING EL NIÑO

M.S. Edwards[1] and G. Hernández-Carmona. [1]Department of Biology, San Diego State University, San Diego, CA 92182 USA; [2]Centro Interdisciplinario de Ciencias Marinas. Ap. Postal 592. La Paz, Baja California Sur 23000. México

The giant kelp *Macrocystis pyrifera* forms extensive forests along the coastal zones of North America from central California, USA to central Baja California, México. Although the northern limit of the species' range is relatively stable near Point Año Nuevo, California, its southern limit has been dynamic during the past 20 years, varying over hundreds of kilometers along the Baja California peninsula. El Niño Southern Oscillations are a major source of this variability, causing devastating losses to giant kelp over hundreds of kilometers of coastline. Recovery following El Niño can delayed and generally reduced by competition from the stipitate kelp, *Eisenia arborea,* which appears more tolerant of El Niño's low nutrient conditions and is able to recover more rapidly, form dense canopies, and prevent giant kelp from recovering to its pre-El Niño southern limit following El Niño. Following the experimental removal of the *E. arborea* canopies, however, *M. pyrifera* can recover to its pre-El Niño southern limit and form thick surface canopies. Results from this study suggest that while *M. pyrifera*'s long-term 'true' southern limit is set by unfavorable temperature and nutrient conditions and the availability of rocky substrates, shorter-term variability near this limit is regulated by increased mortality and recruitment failure from unfavorable temperature and nutrients, episodic events such as El Niños, and competition with *E. arborea.*

18 SANTA MONICA BAY NEEDS YOUR KELP!

Tom Ford and Laura Bodensteiner. Kelp Restoration and Monitoring Project, Santa Monica Baykeeper, P.O. Box 10096 Marina Del Rey, CA, 90295

The Kelp Restoration and Monitoring Project continues to expand its efforts both spatially and temporally along the rocky subtidal of Santa Monica Bay. Descriptions of our efforts and results will be the focus of the presentation. The first generation of giant kelp, *Macrocystis pyrifera,* individuals in our restoration sites off of Escondido Beach Malibu has reached maturity in two years. A one acre kelp bed has been produced through a combination of sea urchin relocation actions and assisted natural recruitment of kelp. This restored bed has been noted by aerial surveys performed by the Central Region Kelp Survey Consortium in 2004 and 2005. Restoration of another historic kelp bed was initiated off of Long Point, Palos Verdes in October 2005, where early results are already being realized.

19 CAN WE SAVE THE BIG FISH?

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Fisheries collapse and the decline of large fishes in marine ecosystems is a critical debate on a global scale. To address one aspect of this debate, we report on a single event, the removal of gill nets from the nearshore arena in the southern California bight, and examine this effect on large marine fishes from this ecosystem. The populations of four apex predators from coastal reef communities had either completely collapsed or severely declined due to over fishing prior to this management action. Both fisheries dependent and independent monitoring programs demonstrated a return of white seabass (Sciaenidae: *Atractoscion nobilis*), soupfin shark (Triakidae: *Galeorhinus galeus*), leopard shark (Triakidae: *Triakis semifasciata*) and giant seabass (Polyprionidae: *Stereolepis gigas*).

20 REEF CHECK CALIFORNIA–A TROPICAL MODEL OF COMMUNITY MONITORING IN A TEMPERATE ENVIRONMENT

C.S. Shuman. Reef Check Foundation, 17575 Pacific Coast Highway, Pacific Palisades, CA, 90272

For nine years, the Reef Check Foundation has trained volunteers to monitor coral reefs around the world and has engaged local communities in sustainable management programs. Noting that the threats to California's nearshore rocky reef ecosystem are similar to those faced by coral reefs, Reef Check is developing a new community-based rocky reef monitoring program in California. The development of the new monitoring protocol has involved important decisions such as which organisms could serve as the best indicators and the level of scientific rigor that is suitable for volunteer divers. Utilizing teams of trained volunteers, Reef Check California is building a statewide monitoring network to help collect the data needed to make informed management decisions while simultaneously building a constituency supportive of science-based management.

21 THE VALUE OF NET-CAGE MARICULTURE AS A FAD IN SOUTHERN CALIFORNIA

C.T. Oakes and D.J. Pondella, II. Vantuna Research Group, Occidental College, Department of Biology, Los Angeles, CA 90041.

Aquaculture impact studies are only beginning to assess the value of net-cages as habitats for wild fishes. Divers conducted monthly fish surveys for one year, from October 12, 2004 to November 17, 2005, determining species composition, abundance and size of all conspicuous fishes aggregating at a net-cage mariculture site in Catalina Harbor, California. Researchers observed high diversity ($H' = 2.29$) and abundance of fishes below the net-cage; 10,234 total with a mean annual density of 142 (SE ±30)/100 m^2. At an adjacent reference reef, we counted 8,452 fishes with a mean annual density of 117 (SE ±20). The second reference reef was a control located 500 m away that had 8,958 total fishes with a mean density of 124 (SE ±20).

The soft-bottom habitat below the net-cage shared 1/3 of its species with both reference reefs, and mean density was not statistically different between the net-cage and reference reef 2, however it was greater than reference reef 1 ($H_{2,360} = 13.25$; $p = 0.0013$), suggesting fish attraction from the nearby habitat. Data on exploited fishes like *Paralabrax clathratus,* suggest an increase in species biomass at the reference reef adjacent the net-cage compared to the net-cage and distant reference reef ($H_{2,120} = 3.76$; $p < 0.01$). The net-cage also attracted a greater biomass of planktivores such as *Chromis punctipinnis* ($z'_{2,120} = 2.60$; $p = 0.03$). Similar densities with increased biomass may represent enhancement of the resources available to the fish community. This also represents a possible increase in fishing potential of the area outside the immediate impact zone of this mariculture operation.

22 PRELIMINARY OBSERVATIONS ON THE LIFE HISTORY OF SALEMA *XENISTIUS CALIFORNIENSIS* FROM SOUTHERN CALIFORNIA

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Despite their commonality within southern California kelp beds, little information regarding the life history of salema (*Xenistius californiensis*) is available. Preliminary investigations into the age and growth of southern California salema suggest a species experiencing principal growth within the first two years before leveling off. The maximum verified age in southern California samples is 10 years. The von Bertalannafy growth parameters for all samples analyzed were $k = 1.9$, $t_0 = 0.332$, and $L_\infty = 162.209$ mm. Analysis of growth parameters by sex indicates females are typically larger than their male counterpart in each age class. Analysis of abundances per net from a nearshore gillnet survey ranging from Newport Beach to Santa Barbara, including Santa Catalina Island, conducted from 1995–2004 suggests denser aggregations ranging from Palos Verdes Peninsula south as well as relatively robust aggregations around Santa Catalina Island. Annual abundances per net also suggest greater reproductive output during ENSO events, as indicated by marked increases in the years following the 1997–1998 El Niño. Further indications of this warm-water preference are exhibited by the sharp decline in mean standard length of gillnet collected individuals in 1999, before a gradual increase over the next three years. Impingement sampling at local generating stations shows similar results with Age-II sized individuals constituting the majority of the 2000 sample. Females comprised a significant proportion of the sample observed during 2004. Gonosomatic indices suggest spawning principally occurs from late spring through summer before noticeably diminishing in early fall.

23 INDICATORS OF GONAD STATE IN CALIFORNIA SHEEPHEAD (*SEMICOSSYPHUS PULCHER*)

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California sheephead, *Semicossyphus pulcher,* are commercially valuable, protogynous hermaphrodites whose external morphology (color and head shape) changes as they transition. This study determined the reliability of using external morphology and sex steroid concentrations to predict gonad state and sought to find morphometric measures that would make sex determination in the field more accurate. Thirty sheephead were collected at Santa Catalina Island, external morphology was documented and gonads and blood were collected. A histological assessment of gonadal tissue was used to determine whether the fish was immature, female, transitional, or male, and whether they possessed functional gonads. Analysis of morphometric data showed morphology cannot be accurately used to sex sheephead; however, testosterone and estradiol concentrations, determined by radioimmunoassays on blood plasma were correlated to gonadal sex. Contrary to previous findings, non-breeding transitional fish were found during the breeding season. Estradiol concentrations were not detected among immature nor transitional fish; however, estradiol was detected in active males. Breeding female sheephead had the highest levels of estradiol. Testosterone concentrations were observed in all sexes caught during summer and did not differ among immature, female, and transitional fish; however, testosterone concentrations increased 4.4-fold in male blood samples as compared to these other groups. Therefore, steroid concentrations during the breeding season may be used to determine sexual state in this hermaphrodite. In addition, the presence of transitionals in the summer suggests that fishing pressure may have skewed sex change during the breeding season, which could reduce overall reproductive output. [Supported by CA Dept. of Fish & Game 07304905].

24 DISTRIBUTION OF PLANKTON NEAR THE MONTEREY UPWELLING FRONT: RETHINKING THE CONCEPT OF PLANKTON AS INACTIVE "DRIFTERS"

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The accumulation of zooplankton at fronts has been known to science for centuries. However, zooplankton behavior is generally under-appreciated as a factor contributing to the observed aggregation of species. I examined zooplankton distributions in the vicinity of the Monterey Bay upwelling shadow front in an effort to resolve whether or not passive advection was the only factor in determining the distribution of different species along the front. On three transects, physical data were gathered to characterize the flow field within the study site, and vertical net tows were gathered in an array encompassing the front to reveal distributional patterns of plankton species. The distribution of planktonic eggs of both fish and invertebrates, which served as passive tracers, demonstrated that the front was strongly convergent along two of the transects, but exhibited transverse shear flow along the third transect where eggs skewed away from the front. Despite differences in flow patterns along the transects, the aggregation of zooplankton always occurred along the front, and the aggregation was stronger in some species than in others. Additionally, the extent to which particular species exhibited a distributional bias near the front was generally correlated with swimming speeds reported in the literature, whether the taxa was holoplanktonic or meroplanktonic, and the ontogenetic stage in question. These data indirectly suggest that plankton behavior, rather than passive advection alone, might account for some of the distributional bias near the front.

25 THE EFFECT OF THE SEA WATER WARMING TREND IN THE EASTERN PACIFIC OCEAN ON THREE DIFFERENT BREEDING TYPES OF DEMERSAL MARINE FISHES

Mike McCarthy. Dept of Biology, CSU Fullerton

Sea water temperature change may be the single most important ecological parameter in the life cycle of marine fishes. It is well documented that sea water temperatures in the eastern Pacific have increased significantly over the last 40 to 50 years. An attempt was made to examine the effect of this warming trend on three different breeding types of demersal fishes—the viviparous (live bearing) Pink Seaperch (*Zalembius rosaceus*), the ovoviviparous (larvae bearing) Stripetail Rockfish (*Sebastes saxicola*) and the oviparous (release of unfertilized sperm and eggs) Pacific Sanddab (*Citharicthys sodidus*). The data examined for this study were water temperature from Orange County Sanitation District (OCSD), Scripps Institute of Oceanography Newport Beach sea surface data, and fish abundance data from OCSD. Correlation analyses were conducted with historical sea surface temperature data from Newport Beach dating back to the 1930s with OCSD's more recent historical data. The correlation analysis between the two water temperature data bases was excellent. A warming trend as stated in other documentation was revealed, although more recent data countered with cooler temperatures. Fish abundance was definitely affected by ENSO events, but a clear advantage to one breeding type of fish was not established.

26 THE RELATIONSHIP BETWEEN EL NIÑO/SOUTHERN OSCILLATION EVENTS AND GROWTH OF JUVENILE WHITE SEABASS (*ATRACTOSCION NOBILIS*)

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Since 1995, the Nearshore Marine Fish Research Program (NMFRP) at CSUN has been under contract with the California Department of Fish and Game and the Ocean Resources Enhancement and Hatchery Program to sample and determine the spatial and size distributions, seasonality, and abundance of white seabass (*Atractoscion nobilis*) in the shallow, nearshore waters of Southern California. One hundred sagittal otoliths were aged from each sampling year between 1997 and 2004. The hatch year of each fish was back calculated using the age at catch and the catch year. Growth rates are determined by using the means of standard length at age for each hatch year. Linear regression equations for each set of hatch year data provide a general growth rate for the first few years of life. The large time span of this study includes several El Niño/Southern Oscillation (ENSO) events of varying strengths, all of which caused noticeable changes in the sea surface temperature in the Southern California Bight. This study relates the growth rate of juvenile white seabass and the changes in the local ocean temperatures due to ENSO conditions.

27 LIFE HISTORY PARAMETERS AND COURTSHIP BEHAVIOR OF BLACK PERCH (*EMBIOTOCA JACKSONI*) WITHIN THE SOUTHERN CALIFORNIA BIGHT

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Black perch (*Embiotoca jacksoni*) are a common reef fish associated with nearshore habitats along California with the majority of the population occurring within the southern California Bight. Black perch were collected monthly from January 2004 to January 2005 with a Hawaiian Sling, as by-catch from the Ocean Resources Enhancement and Hatchery Program (OREHP) for white seabass and as by-catch from power plant collections. Animals were collected throughout southern California from Santa Barbara to Carlsbad including Santa Catalina Island. Specimens were collected and processed to determine their physical characteristics, growth, sex ratio, periodicity of reproduction and gestation. Additionally, courtship observations were conducted on SCUBA along the King Harbor Breakwall in Redondo Beach, California from January 2004 to December 2005 to verify periodicity of courting and the associated behaviors. Specimens ranged from 75–215 mm standard length and from 18–487 g in total body weight. Seven age classes were determined with the majority of the growth occurring between age class zero and one. The majority of specimens captured ranged form age class one to three. Pregnant individuals were recorded from December to May with the youngest pregnant female being age class one. Mean monthly GSI for males peaked from July to November with the highest mean occurring in October (GSI = 1.47). Courtship behaviors were seen among aggregations and in pairs from July to November, with the males being the primary aggressors. Courtship postures occurred along the bottom of the reef with pairs departing into caves for final copulation.

28 THINK SMALL: BENEFITS OF APPROACHING THE POPULATION GENETICS OF THE TIDEWATER GOBY (*EUCYCLOGOBIUS NEWBERRYI*) FROM THE LEVEL OF THE INDIVIDUAL

Dent A. Earl, David K. Jacobs, Kristina D. Louie, Carolyne Bardeleben, Carles Vila & Camm C. Swift. Presenter's Contact: UCLA, Ecology and Evolutionary Biology Department, 621 Charles E. Young Drive South, Los Angeles, CA 90095. 310-206-7885, daearl@ucla.edu

In traditional population genetics, population level statistics have been used to describe relationships between populations. These traditional metrics, such as Fst, can provide insight into levels of gene flow between populations.

However, in complex and dynamic population settings, such as seen in the tidewater goby (*Eucyclogobius newberryi,* Federally Endangered) metapopuation, these traditional metrics do not describe relationships between populations with sufficient resolution and the metrics can make no statements at the individual level. As a result of these limitations we have applied methods that consider individual fish in addition to traditional whole population metrics.

To this end we have applied the software package STRUCTURE to microsatellite data from tidewater gobies collected in the Santa Barbara region of California. Both of these packages make use of assignment tests, which cluster individual samples due to genetic similarity. We have compiled a detailed picture of apparent movement between goby populations using the output of this program, field data and natural processes information. These findings reveal a genetic structure that reflects the extinction-recolonization metapopulation process rather than a simple geographic structure. Approaching the data with more sensitive tests has helped further our understanding at both the level of individual migration and also within the scale of metapopulation dynamics.

29 THE EFFECTS OF DIEL AND TIDAL CYCLES ON THE ABUNDANCE OF HARBOR SEALS, *PHOCA VITULINA RICHARDSI,* IN CHALK COVE, SANTA CATALINA ISLAND

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The abundance and behavior of Pacific harbor seals (*Phoca vitulina richardsi*) was observed at Chalk Cove, Santa Catalina Island to determine how the seals use the cove. Seals were counted and observed over 24 hr periods and their behaviors were analyzed to determine whether there was evidence of diel or tidal cyclicity. There was no difference in the number of seals hauled out versus in the water; however, there were significantly more seals in the cove during the daylight hours than during dawn/dusk or night hours. The highest abundance of seals hauled out were observed during medium to medium-low falling tides and no seals hauled out during high tides due to the submerged rocks. Harbor seals show distinct diel and tidal patterns, which do not appear to be affected by human related activities (boating and kayaking) immediately adjacent to or within Chalk Cove.

30 PLASMA TESTOSTERONE LEVELS CORRELATE WITH SPERMATOGENESIS BUT NOT GSI IN MALE ROUND STINGRAYS (*UROBATIS HALLERI*)

C.G. Mull, C.G. Lowe, and K.A. Young. Department of Biology, California State University, Long Beach 90840

Round stingrays are a common near shore elasmobranch in southern California and are known to breed annually during the late spring–early summer. While breeding behavior, gonadosomatic index (GSI), and hormone levels correlate in some species, this is not true of all elasmobranchs. Previous studies have characterized the life history of the round stingray, while this is the first study to concurrently examine androgen levels and gonadal development in this species. We hypothesized that the annual cycle of testosterone in a wild population of male round stingrays was correlated with seasonal gonad development and spermatogenesis. Round rays were collected monthly for 12 months in Seal Beach, CA. Gonadal tissue and blood samples were collected for each ray, and processed for histological examination and analyses by radioimmunoassay, respectively. Seasonal changes in testes structure were categorized into three phases: inactive (May–July), recrudescent (August–October), and degenerative (November–April). The inactive phase is characterized by suppressed androgen levels and reduced GSI. During the recrudescent phase testosterone and GSI increases, and spermatogenesis is characterized by a transition from primary spermatagonia to later stages. The degenerative phase is characterized by a reduction in GSI and a further increase in testosterone levels. Interestingly, GSI peaked in October, 5 months before the established mating season, and peak sperm production occurred in December, two months after peak GSI and 3 months prior to mating. These results suggest that plasma testosterone is a more reliable indicator of seasonal maturation of testes in round stingrays than GSI.

31 CRANIAL ENDOTHERMY IN THE MOONFISH (*LAMPRIS GUTTATUS*)

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Billfishes, butterfly mackerel, tunas and lamnid sharks have evolved cranial endothermy by convergence. The moonfish (*Lampris guttatus*) shares certain behaviors and characteristics with these fishes: they migrate vertically within the water column, experiencing a wide range of seawater temperatures and rapid ambient temperature changes. The purpose of this study was to identify the heat producing structure and the heat retention mechanism necessary for cranial endothermy in moonfish. To identify the heat source and the heat retention mechanism we dissected several moonfish heads, and examined tissue samples using light microscopy and electron microscopy. To visualize and document the three-dimensional arrangement of these structures we used magnetic resonance imaging (MRI). To identify highly aerobic tissue that may serve as the heat source we measured citrate synthase (CS) activity from each extra-ocular muscle. The proximal lateral rectus extra-ocular muscle (PLRM) appears to be the primary heat source because it is adjacent to the brain, it has a high CS activity (an index of mitochondrial density and oxidative capacity), and it is perfused by blood vessels arranged as a putative counter-current heat exchanger (made up of numerous sets of thick-walled arteries surrounded by thinner-walled veins). We also found that the PLRM is well insulated by a thick layer of adipose tissue that reduces conductive heat loss from the PLRM to the water. By showing that moonfish possess a heat source and a heat retention mechanism necessary for cranial endothermy, this study contributes to our understanding of the convergent evolution of endothermy in fishes.

32 THE POTENTIAL FOR LACTATE PROCESSING IN WHITE MUSCLE OF ENDOTHERMIC AND ECTOTHERMIC SHARKS

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During burst swimming, powered by anaerobic metabolism, lactate accumulates in the fast, glycolytic (white) locomotor muscle (WM) of fishes. Lactate dehydrogenase (LDH) activity, an index of fish anaerobic capacity, is higher in the shortfin mako shark than in leopard and blue sharks. The purpose of this study was to determine if the mako shark has a correspondingly higher capacity to reconvert lactate to glycogen during recovery from burst activity and if the WM has a higher capacity to resynthesize glycogen than the liver, red muscle (RM), or heart. Glycogen resynthesis requires pyruvate carboxylase (PC) or malic enzyme (ME) and phosphoenolpyruvate-carboxykinase (PEPCK) to synthesize phosphoenolpyruvate (PEP), and fructose-1,6-bisphosphatase (FBPase) to synthesize fructose-6-phosphate (F6P). We found no evidence that the WM can convert lactate to PEP because there was no detectable PC or PEPCK activity in any of the three shark species. Furthermore, PC was not detected in any tissue studied. In both mako and blue sharks, the liver, RM, and heart all had measurable ME, PEPCK, and FBPase activities, and thus should be able to resynthesize glycogen from lactate, but at low rates. In the leopard shark, RM and heart can convert lactate to PEP (both have ME and PEPCK), and the liver and WM can synthesize F6P (both have FBPase). Liver PEPCK and heart ME activities were significantly higher in the mako than in the blue and leopard sharks, indicating that the mako shark may have a higher capacity for glycogen resynthesis, corresponding with its higher ability to produce lactate.

33 'BUT YOU CAN'T TAKE THE COUNTRY OUT OF THE LARVA': SITE EFFECTS IN CALCIFIED STRUCTURES USEFUL FOR LARVAL TRACKING STUDIES

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Statolith chemistry can be used to discriminate between sites of origin in *Kelletia kelletii* larvae. Previously, scientists assumed that variation in calcified part chemistry was largely determined by factors such as seawater element concentration and temperature. This assumption is well supported by laboratory culturing experiments; however recent field studies show weak concordance between seawater and calcified part chemistry. We hypothesize that natal site may affect statolith chemistry, and performed field and laboratory culturing studies to examine the effects of natal site, temperature and seawater element concentration on statolith chemistry. We reciprocally transplanted egg cases among three sites (Salta Verde Pt, Catalina, White Point, Palos Verdes, and Los Angeles Harbor) in the field, and among water from those sites in the laboratory. Culture temperatures varied from 10 to 18 °C. Newly laid eggs were used for culturing, and a subset was frozen prior to analysis to tease apart effects of intra-capsular element content versus other site effects. Analyses were via laser-ablation or solution-based inductively coupled plasma mass spectrometry. Seawater element concentration significantly affected barium and lead, and temperature was negatively correlated to strontium, barium and lead concentrations in statoliths. Site significantly affected lead and magnesium; L.A. Harbor statoliths had lower lead concentrations regardless of the temperature or seawater they were cultured in, possibly due to physiological exclusion of lead. We show that temperature, seawater and natal site influence statolith chemistry, with important implications for environmental history reconstruction, and for use of calcified structures in larval tracking studies.

34 ECTOPARASITES OF FISHES ASSOCIATED WITH WASTEWATER DISCHARGE IN THE SOUTHERN CALIFORNIA BIGHT

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The southern California coastal marine environment has been subjected to numerous inputs of pollution, however little is known about pollution effects on infestation of parasites on fishes. Pollution exposures may result in stress, potentially decreasing the immune response in fishes and increasing their susceptibility to diseases and parasites. A variety of marine organisms and tissues have been evaluated as potential biological indicators of pollution. However, due to the range of contaminants, contaminant concentrations, and exposure time that marine organisms experience, it is unclear which fishes and/or anomalies are relevant. During the Southern California Bight 2003 Regional Marine Monitoring Survey (Bight '03), selected marine fishes were collected using otter trawls from 79 stations adjacent to and away from four large wastewater outfalls and inspected for ectoparasites. This study evaluated the conditions around wastewater outfalls in terms of infestation of ectoparasites on fishes and examined if specific parasite and/or host species could be used as bioindicators of environmental stress in the Southern California Bight. Results showed many parasites had high host specificity, implying coevolution with their fish hosts, and high attachment-site specificity. Parasite prevalence and intensity varied according to host species, which suggests that some host species may be more resistant to parasitization or have evolutionarily lost their parasites. Hosts examined totaled 15,848 individuals representing 34 species, and ectoparasites removed totaled 14,620 individuals, comprised of monogeneans, leeches, branchiurans, copepods, and isopods.

35 THE OPTIC NERVE SHEATH DIAMETER IN ASSOCIATION WITH INCREASED INTRACRANIAL PRESSURE

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The objective of this research project is to determine if emergency department (ED) physicians can use bedside ultrasound (BUS) to accurately diagnose elevated intracranial pressure (ICP). Elevated ICP often forms from intracranial hemorrhages, cerebral edemas, or intracranial masses, such as tu-

mors. Previous studies conducted have shown a correlation between elevated ICP and an increase in the size of the optic nerve sheath diameter (ONSD); however, only a limited amount of research has been performed in which BUS is used to determine the ONSD. In this research study BUS was used to measure the ONSD. The BUS results were then compared to the head CT scan results to determine whether a correlation was evident between the BUS scan and any elevated ICP findings from the head CT scan. Both BUS and head CT scans suggest that a patient with an ONSD greater than 5.1mm may have elevated ICP. From April 2005 to September 2005, 100 patients met the study's inclusion criteria. The study results determined that the mean ONSD of the left and right eyes were 4.7869mm (Standard Deviation [SD] 1.1779) and 4.7364mm (SD 1.2381) respectively. Five of the study's patients were found to have elevated ICP, and the mean ONSD of their left and right eyes were 5.08mm (SD 1.3554) and 5.12mm (SD 0.8349) respectively. The results from this research are ongoing, as not enough patients have been enrolled to positively conclude whether or not measuring the ONSD by use of BUS can be an effective modality in the diagnosis of elevated ICP.

36 THE RESPONSE OF FLYING INSECTS TO SCORPION FLUORESCENCE

C.T. Kloock. California State University, Bakersfield, Department of Biology, Bakersfield CA, 93311

Scorpions fluoresce when exposed to ultraviolet light. However, since most scorpions are nocturnal, the idea that this fluorescence has an ecological function has not been explored. A first step in determining the plausibility of any hypothesis having to do with an ecological function of scorpion fluorescence is to determine whether other organisms respond to scorpion fluorescence under natural conditions. To determine whether or not some potential prey, specifically flying insects, respond to scorpion fluorescence under natural conditions, I compared the number of flying insects captured on sticky traps containing fluorescent scorpions to the number captured on traps containing non-fluorescent scorpions during both full and new moons. The results show that aerial insects avoid fluorescing scorpions during the full moon, when nocturnal UV light is at its peak, but not during the new moon when it is weakest.

38 CHEMICAL AND NON-CHEMICAL METHODS FOR REMOVING INVASIVE PLANTS: TWO CASE STUDIES

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Invasive non-native vegetation poses a real threat to the integrity of indigenous plant and animal communities. The most damaging invasive species can fundamentally alter the composition of species in a community through direct or indirect competition for resources such as nutrients, water, sunlight, and space. The end product is a change to the functionality of the ecosystem as a whole at the expense of the native biota and quite often the physical features of the landscape itself.

Natural resource managers in the state parks system have been given the daunting task of assessing the extent of weed infestations in their parks. In doing so they must also prioritize which weed species and which individual weed populations pose the greatest threat to park resources. Projects are then designed to curtail the spread of the highest priority infestations into surrounding unaffected areas as well as to eliminate infestations altogether when economically feasible. The methodologies most frequently employed involve vegetation removal via mechanical means, chemical means, or some combination of the two.

At Pt. Dume State Preserve, ice plant (*Carpobrotus edulis*) was effectively removed by a combination of mechanical and chemical treatments. Solid mats of ice plant were sprayed in late summer/fall with a low concentration herbicide mixture of glyphosate and triclopyr. The edges of the ice plant mats were pulled free from the surrounding native vegetation and placed in the middle of the chemically treated area. The ice plant was left in place where it died. Natural recruitment of native species rapidly filled in the voids left from the dead ice plant

In Malibu Creek State Park, an ongoing effort is under way to remove non-native vegetation from riparian corridors primarily through mechanical means. Species such as periwinkle (*vinca major*) and poison hemlock (*Conium maculatum*) are removed with hand tools, and cleared areas are subsequently planted with native riparian species such as California blackberry (*Rubus ursinus*), California rose (*Rosa californica*), bay laurel (*Umbelularia californicum*), and mugwort (*Artemisia duglasiana*).

39 THE BRADLEY METHOD OF "BUSH" REGENERATION

Jo Kitz, Program Director, Mountains Restoration Trust

Abstract not received

40 USING INTEGRATED VEGETATION MANAGEMENT TO CONTROL NON-NATIVE INVASIVE SPECIES AND RESTORE NATIVE ECOSYSTEMS IN THE SANTA MONICA MOUNTAINS"

Marti Whitter. Fire Ecologist, National Parks Service

Abstract not received

41 Title and abstract not received

Ellen Mackey. Field Ecologist/Biologist, Los Angeles & San Gabriel Rivers Watershed Council

42 ROLE OF WATERSHED-SCALE PHYSICAL PROCESSES IN SHAPING HABITAT REQUIREMENTS OF RIPARIAN DEPENDENT FAUNA

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Watershed planning is becoming an increasingly common approach to management of aquatic resources and their sensitive fauna. Although watershed plans often address physical processes that affect the integrity of wetland habitats, they often fail to draw a direct connection between these processes and the habitat requirements for various life stages of sensitive wetland fauna. In this study, we evaluated the requisite physical habitat components for five Federally-endangered wetland and riparian dependent species and related them to the key hydrologic and geomorphic processes that influence the habitat viability for various life-stages. The species analyzed represented several taxa: tidewater goby (*Eucyclogobius newberryi*; an estuarine fish), southern steelhead (*Oncorhynchus mykiss*; an anadromous fish), the arroyo toad (*Bufo californicus*; an amphibian), and two migratory bird species, least Bell's vireo (*Vireo bellii pusillus*) and southwestern willow flycatcher (*Empidonax traillii extimus*). The physical habitat components necessary to provide key life functions of all the species analyzed were controlled by four geomorphic processes—hillslope sediment yield, mass movements and debris flows, in-channel sediment transport, and sediment storage, and three hydrologic processes—infiltration and interflow, runoff, and discharges from springs, seeps, and shallow aquifers. These processes operate at broad spatial and temporal scales and ultimately control the distribution of species within the watershed. Understanding the link between physical processes and habitat components is critical to the long-term protection and appropriate habitat restoration for these species.

43 STATUS AND DISTRUBUTION OF THE INLAND FISHES OF COASTAL SOUTHERN CALIFORNIA

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The approximately nine species of inland fishes of coastal southern California include two elements: (1) the southern extreme of a temperate coastal fauna (steelhead, anadromous lampreys, sticklebacks, sculpins) and, (2) relict, cool water, endemic freshwater species of the Los Angeles Basin (freshwater lamprey and the South Coast Minnow Sucker community [SCMSC] of Santa Ana sucker, arroyo chub, and Santa Ana speckled dace), dating from ancient hydrological connections with the Colorado River (to the east) and the Central Valley (to the north). The coastal forms often range as far south as northern Baja California. Most of the species were originally widespread on the well-watered Los Angeles basin and environs. Today the three SCMSC species occur together in only two places, lower Big Tujunga Wash (Haines Creek, Los Angeles River drainage) and the upper San Gabriel system (East, West, and North Forks, San Gabriel River). Santa Ana sucker and arroyo chub also occur in the middle Santa Ana River; farther upstream speckled dace occur in eight to ten scattered localities at the base of the San Bernardino, San Gabriel, Santa Ana, and San Jacinto mountains. Arroyo chubs also occur in a few drainages adjacent to the Los Angeles Basin and have been widely introduced elsewhere in coastal drainages. Ironically introductions have created extralimital fish communities more diverse than currently exist within their original ranges. In the thirteen years since the last summary, most of the local species have acquired special conservation status by being listed at the State or Federal level.

44 STATUS, DISTRIBUTION, HABITAT AND POPULATION SIZE-STRUCTURE ESTIMATES FOR THE THREATENED SANTA ANA SUCKER (*CATOSTOMUS SANTAANAE*)

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The federally Threatened Santa Ana sucker occurs presently in the lowland floodplain of the Santa Ana River, and mainly in the upland, mountain tributaries of the San Gabriel and Los Angeles rivers. An unlisted population is in the Santa Clara River, where it is thought to be introduced. An overview of the habitat of various life history stages (egg, larval, juvenile and adult) is given. A comparison of the results of population estimates by multiple pass depletion studies in the San Gabriel and Santa Ana Rivers are presented.

Population estimates in the summer months in the Santa Ana River by the multiple pass depletion method at three 100 meter sites showed no significant change over 5 years. For 3 of these years populations were also examined by snorkeling in the same river reach. Both methods yielded a rough estimate of one fish per meter over the approximately 7.6 kilometer study area. Populations are described in various important habitats, and recommendations for habitat protection and enhancement, and species recovery are suggested.

45 STATUS OF THE SANTA ANA SUCKER (*CATOSTOMUS SANTAANAE*) IN SOUTHERN CALIFORNIA: PATTERNS AND TRENDS IN CONDITION INDEX AND HABITAT PREFERENCE THROUGHOUT ITS RANGE

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Five years of standardized samples of *Catostomus santaanae* (Santa Ana sucker) in the Santa Ana River (SAR) were compared among years, and with other lowland (Los Angeles and Santa Clara Rivers basins) and mountain (East Fork, San Gabriel River) populations. Using all fish collected each year, there appear to be significant differences in condition (two measures: mass divided by standard length [gmm condition] and observed divided by predicted mass [oe condition]) among years for the SAR samples (Kruskal-Wallis; $p = 0$). However, there appear to be two size classes among the SAR samples, and after separating these data into the two size classes, there appears to be no difference among the small size class fish for oe condition (Kruskal-Wallis $p = 0.14$). For the large size class for both condition measures, and for the small size class for gmm condition, there were significant differences among years (Kruskal-Wallis $p = 0$ for all three of these). There appears to be a small and non-monotonic decline in gmm condition over the sampling years, and very little of this decline is accounted for by year. Comparing all fish from various sites, it appears that fish from the East Fork of the San Gabriel River have higher gmm condition than lowland fish.

Attempting to explain these findings, we document and compare habitat conditions. Based on separate habitat selectivity studies of suckers in lowland and mountain sites we find much more of the favored habitat present in the mountain sites, e.g. boulder-cobble-gravel substrate, greater depth and velocity.

46 RARE OCCURRENCES OF A COMMON SPECIES: SPECKLED DACE AND THEIR STRUGGLE FOR SURVIVAL IN SOUTHERN CALIFORNIA

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Speckled dace (*Rhinichthys osculus*) are possibly the most widely distributed fish in western North America, occurring in nearly every major drainage from British Columbia, Canada to Sonora, Mexico.

Until recently, descriptions of different forms of speckled dace have been difficult due to the wide range of habitats it occupies and high variability in body form. Of seven unofficially recognized subspecies statewide, only one is found south of Point Conception. Santa Ana speckled dace historically inhabited the upper portions of the Los Angeles, San Gabriel, and Santa Ana River systems. It currently occupies only remnants of its historic range, with a limited distribution restricted almost entirely to the headwaters of the Santa Ana and San Gabriel Rivers. It was petitioned for listing as endangered in 1994, but was denied because the subspecies was not formally described. A review of speckled dace natural history, regional taxonomy, and known local distributions are presented along with information from ongoing work to better define its taxonomic designation, present status and conservation needs.

47 TIDEWATER GOBY SEASONAL HABITAT PREFERENCES IN A NORTHERN CALIFORNIA LAGOON, WITH REFERENCE TO ARTIFICIAL BREACHING

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Environmental factors contributing to seasonal tidewater goby (*Eucyclogobius newberryi*) habitat selection were investigated in the Lake Earl and Tolowa Lagoon system in Del Norte County. Lagoon morphology provides for a wide variety of water quality and habitat types available to tidewater goby during most of the year. Substrate type, vegetative cover, depth, water quality variables, artificial breaching of the sandbar, and other seasonal factors were analyzed in relation to all goby life-stages. Seasonal habitat preferences for spawning tidewater goby and sub-adult foraging, planktonic larval refugia locations, and stranding pools were identified. Initial results provide information on life history requirements characterization and habitat preferences for tidewater goby. A 25-square meter *Block-Net* drop trap sampling protocol provided a landscape-scale sampling tool for a more accurate measurement of species richness and diversity in shallower open water conditions. This study demonstrates the importance of a properly designed and implemented sampling program to assess species population densities with minimum disturbance and fish escapement. Four hundred and eighty sites were sampled during twelve months, providing a robust database on the seasonal ecology of invertebrate and fish assemblages in the lagoon system. Artificial breaching consequences on tidewater goby, such as stranding, were assessed seasonally.

48 IMPACTS OF EXOTIC SPECIES ON NATIVE AQUATIC SPECIES DISTRIBUTION IN TWO SOUTHERN CALIFORNIA RIVER SYSTEMS

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ECORP Consulting, Inc. (ECORP) conducted two years of exotic aquatic species assessment and removal technique evaluation in two river systems in southern California; San Mateo Creek and Santa Margarita River and San Mateo Creek. In 2004 and 2005, ECORP conducted habitat assessments and removal of exotic aquatic species in the lower Santa Margarita River and Estuary from March through September, 2004 and 2005. This effort was conducted to 1) reduce the potential for predation of tidewater goby, and 2) improve conditions for re-establishment of tidewater goby.

The Santa Margarita River historically supported four native freshwater fish species, including the partially armored threespine stickleback (*Gasterosteus aculeatus*), Pacific lamprey (*Lampetra tridentata*), steelhead (*Oncorhynchus mykiss*), and the Arroyo chub (*Gila orcutti*). The river is currently dominated by exotic species, such as common carp (*Cyprinus carpio*), black bullhead (*Ameiurus melas*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), redeye bass (*M. coosae*), mosquitofish (*Gambusia affinis*), bullfrog (*Rana catesbeiana*), and red swamp crayfish (*Procambarus clarkia*).

In contrast, the Santa Margarita estuary historically contained many native fish species, including the federally endangered tidewater goby (*Eucyclogobius newberryi*). The estuary also contains several non-native estuarine species, such as the yellowfin goby (*Acanthogobius flavimanus*) and several non-native freshwater fish species, mostly ictalurids and centrarchids that enter the estuary seasonally from upstream sources.

In August 2003, ECORP conducted habitat assessment surveys along 10 miles of San Mateo Creek in the Cleveland National Forest, followed by exotic species removal efforts in the upper 2.2 miles of the surveyed stream in November and December, 2003, and again in September and October, 2004. The study area included 46 pools that were treated using a variety of techniques. Five introduced aquatic species were encountered both in 2003 and 2004, including: bullfrog, black bullhead, bluegill, mosquitofish, and red swamp crayfish. Four native amphibian and aquatic reptile species were also observed, including Pacific treefrog (*Hyla regilla*), California treefrog (*H. cadaverina*), California newt (*Taricha torosa*), and western pond turtle (*Clemmys marmorata*).

The current populations of exotic and native species from the two stream systems are compared and contrasting impacts on the native species are examined.

49 EXTENT OF FISHING AND FISH CONSUMPTION IN VENTURA AND LOS ANGELES COUNTY WATERSHEDS IN 2005

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Although fishing is an important recreational activity in southern California, there is no recent description of its distribution in the watersheds. With increased focus on pollution control, there is a need for understanding the extent of fishing and fish consumption as a beneficial use in these watersheds. This study describes the extent of fishing and fish consumption in six watersheds of Ventura and Los Angeles County: Ventura River, Santa Clara River, Calleguas Creek, Malibu Creek, Los Angeles River, and San Gabriel River. Of about 46 freshwater fish species in these watersheds, 85% are introduced species. We conducted a field survey during January–December 2005 to census fishers by fishing areas (estuary/river mouth, coastal terrace streams, urban lakes, mountain reservoirs, and mountain streams) in the watersheds. Fishers were interviewed to obtain fish consumption information. Teams of two interviewers conducted surveys on four week days and five weekend days per month during this period. Sites were selected from a stratified random sampling design. In all, 273 site visits were conducted at 85 sites. We observed 1,244 fishers and 496 were interviewed; of these, 238 consumed fish they caught. Most fishers and consumers were at urban lakes and mountain reservoirs, fewer at mountain streams and estuary/river mouths, and least at coastal terrace streams. Stocked rainbow trout (*Oncorhynchus mykiss*), channel catfish (*Ictalurus punctatus*), and largemouth bass (*Micropterus salmoides*) were the most frequently consumed species. Information, including consumption rates, from this study will be used in Total Maximum Daily Load (TMDL) assessments of these watersheds.

50 THE CALIFORNIA NEWT: NATURAL HISTORY AND CHEMICALLY-MEDIATED INTERACTIONS

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The California newt (*Taricha torosa*) is a chemically-defended amphibian that spends several months out of the year on land, but returns to freshwater ponds and streams for several months to breed. During this annual aquatic stage, adult newts feed on a diverse diet including both invertebrates and conspecific embryos and larvae. Although much attention has been given to the conservation of this animal due to its listing as a Species of Special Concern, recent investigations have focused on the role of the newt's chemical defense, tetrodotoxin (TTX) in ecological interactions. It appears that the toxin serves multiple functions, facilitating predator deterrence, cannibal detection, and mating attraction. Furthermore, larval and adult newt olfaction provides an intriguing physiological mechanism for context-sensitive behaviors such as predator avoidance and food search.

51 USING STREAM CHEMISTRY TO UNDERSTAND WATERSHED DYNAMICS

Helen Jung, Terri Hogue, University of California at Los Angeles. Laura Rademacher, University of Pacific. Sheila Morrissey, University of California at Santa Barbara. Tom Meixner, University of Arizona

Urban-wildland areas are periodically affected by wildfires. Post-fire changes in land cover (e.g. vegetation and soils) affect water quality as well as alter watershed flowpaths. The study of two burned watersheds located in the San Bernardino Mountains (City Creek and Devils Canyon) will further understanding of watershed response and long-term recovery in the wake of wildfires. The two watersheds are very close in proximity (~10km) and precipitation data, discharge patterns, geochemistry, and elevation are similar. Increased hydrophobicity alters hydrologic flowpaths by increasing overland flow and decreasing infiltration to the subsurface. Watershed chemistry can be utilized to understand the subsequent changes in hydrologic processes and explore the mixture of representative streamwater components. Geochemical data collected from streamwater, springs, soilwater and precipitation are used to determine the distribution of water and solutes in the contributing flowpaths within the watersheds. A chemistry analysis shows increases in cations (Ca, Mg, K, and Na), and decreases in Chloride in the stream after the fire. An End Member Mixing Analysis (EMMA) was used to predict the contribution of three components (soil water, groundwater and overland flow) in Devils Canyon from both pre- and post-burn periods during the rainy season (December to April). Stream water samples from immediate post-burn indicate components more similar to the precipitation end member, whereas samples from the pre-burn period are more similar to the groundwater member. Gradual recovery of the watershed is being evidenced by a return to soil and groundwater compositions.

52 INNOVATIVE MONITORING TECHNIQUES TO ASSESS WATER QUALITY LOADINGS FROM NATURAL LANDSCAPES

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One of the challenges in developing TMDLs and estimating pollutant loads in dry and wet weather discharges from coastal watersheds is accounting for the natural contribution of certain constituents from undeveloped catchments. The underlying geology in a watershed can directly affect constituent concentrations. Because of limited data on the contributions of pollutants from undeveloped lands, many TMDLs are written with load allocations based on data from other parts of the country, or anecdotal data from previous time periods. This can result in TMDLs with overly stringent load allocations. To meet the challenges associated with remote watershed monitoring, MACTEC Engineering and Consulting, Inc. has been working closely with the Southern California Coastal Water Research Project (SCCWRP) for the past 5 years developing innovate flow monitoring and automated sampling techniques to sample in remote watersheds to obtain natural, background concentrations of constituents. This presentation discusses some of the innovate techniques developed to successfully sample previously un-sampled undeveloped catchments during wet weather conditions. In addition, two distinct watersheds, monitoring strategies, and associated sampling methodologies will be discussed. Multiple bottle pollutograph sampling is conducted if 10 or more grab samples are required and/or the site is safe for field crews. Hybrid automated sampling is the preferred method if site safety or lower analytical costs are a concern.

53 WATERSHED-BASED SOURCES OF TOTAL COPPER, LEAD AND ZINC IN URBAN STORMWATER

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Emissions of trace metals as wash-off during rain events have been shown to produce large loads in urban stormwater runoff. Little is known, however, about the watershed-based sources and factors that influence temporal patterns of watershed-based metals loading in surface waters throughout the urban Los Angeles region. This knowledge is important for developing predictive models and management strategies to affect overall watershed loading. The goals of this study were (1) to examine trace metal event mean concentrations (EMC), fluxes, and mass loadings associated with stormwater runoff from urban (developed) and undeveloped watersheds, and specific land uses; (2) to evaluate how trace metal loadings compare to loadings from point sources, and (3) to assess how the concentrations of total metals in runoff compare to published water-quality criteria. To achieve these goals, trace metal concentrations (e.g. copper, lead and zinc) were measured from eight different land use types over 11 storm events in the Ballona Creek, Dominguez Channel, Los Angeles River and Santa Monica Bay watersheds during the 2000/01–2004/05 storm seasons. In addition, runoff samples were also collected from eight mass emission sites (in-river) during 15 different storm events. For all storms sampled, the highest metal concentrations occurred during the early phases of stormwater runoff. Stormwater runoff of trace metals from watersheds produced a similar range of annual loads based on comparisons to annual load estimates from point sources. Mean fluxes at land use sites ranged from 23.6 to 1238, 0.1 to 1272.2, 6.1 to 33,189.3 (g/km^2) for total copper, total lead and total zinc respectively. Industrial land use sites, contributed higher storm event mean concentrations (EMC) and fluxes of all trace metals than other land use types and were significantly different ($p < 0.0001$) from all land use sites except recreational. Mean mass emissions (ME) of total copper, total lead and total zinc were highest at agricultural, industrial and commercial sites. Nearly all land use sites revealed greater than 50% of total copper and total zinc runoff samples exceeding the California Toxics Rules (CTR) for acute freshwater criteria. Seasonal differences in metals loading were observed at both mass emission and land use sites. Early season storms produced significantly higher ($p < 0.0001$) metal loads than late season storms. Storm size was also significant ($p < 0.0001$) but only at land use sites.

54 STORMWATER TOXICITY EVALUATION OF MAJOR RIVERS ENTERING THE SOUTHERN CALIFORNIA BIGHT

John Rudolph[1], Chris Stransky[1], Howard Bailey[1], Steve Bay[2], and Darrin Greenstein[2]. [1]Nautilus Environmental, San Diego, CA, 92121; [2]Southern California Coastal Water Research Project, Westminster, CA, 92683

In an effort to assess the overall ecological condition of the Southern California Bight, this project was designed to address the magnitude and persistence of toxicity in nine river discharges and a stormwater plume in Southern California coastal waters using gametes of the purple urchin *Strongylocentrotus purpuratus*. Magnitude of runoff toxicity was determined by collecting and testing samples from each river near its ocean discharge point and its offshore stormwater plume. Samples were collected during three storm events (≥0.25 in.), which occurred on February 23, 2004 (eight rivers), February 12, 2005 (two rivers), and March 24, 2005 (seven rivers). Persistence of toxicity following a storm event was evaluated by testing samples collected one, three, and five days following each storm. Sample holding time effects were evaluated by re-testing selected samples on multiple occasions after collection. Test results and data analyses (e.g., among rivers and between years) are presented. Toxicity was observed in several rivers, but the degree of toxicity, when present, often varied substantially between samples collected immediately following each storm, between storm events, and during sample holding.

55 QUANTITATIVE MICROBIAL SOURCE TRACKING USING *BACTEROIDALES* AND HUMAN VIRUS MONITORING IN CALLEGUAS CREEK WATERSHED

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A new probabilistic microbial source tracking (MST) approach based on *Bacteroidales* and human-specific viruses was applied to provide quantitative, host-specific fecal source information for the development of a bacteria total maximum daily load (TMDL) for the arid Calleguas Creek Watershed in Southern California. This field study was the first to utilize a suite of TaqMan quantitative polymerase chain reaction (PCR) systems for *Bacteroidales*; targeting genetic markers for a universal sequence, as well as specific markers for inputs from humans, cows/horses, and dogs. Hollow-fiber ultrafiltration was used to simultaneously concentrate these anaerobic bacteria, along with adenovirus and enterovirus, in 73 100-liter samples collected from the watershed over the course of eleven months. Field- and laboratory-based validation tests using fecal and aqueous samples demonstrated the efficacy of each *Bacteroidales* marker. The marker sequence for universal *Bacteroidales* was detected in 100% of samples, allowing for the calculation of host-specific to universal *Bacteroidales* ratios, which are indicative of the relative abundance of each marker over space and time. One of the most prominent features of the MST dataset was the distinct bifurcation between wet and dry weather; cow/horse and dog concentrations and ratios were significantly higher during wet weather, while human ratios were lower. Such patterns suggest that frequent indicator bacteria water quality objective exceedances during wet weather are due to loading from non-human sources. Our MST "toolkit" of quantitative MST with *Bacteroidales* and human-specific virus monitoring proved useful for development of watershed-scale conceptual models of the fate and transport of bacteria derived from wastewater, domestic animals and livestock.

56 DRY WEATHER RIVER RUNOFF IN THE SOUTHERN CALIFORNIA BIGHT

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Dry weather river flow in southern California is generally not considered a major environmental concern in contrast to the considerable concern for wet weather runoff. While our major sewage outfalls are a type of river inflow, southern California, and in particular the region of San Pedro has significant continuous surface river inflow from the Los Angeles and San Gabriel Rivers. Because of their proximity, these two sources often appear as a single river plume extending along the coast from Los Angeles and Long Beach harbors. While not readily obvious in ocean color observations, the plume is clearly defined by its lower salinity compared to the ambient surface water. The plume is significant because of its potential to impact the physical dynamics of the nearshore region, phytoplankton blooms that may include harmful algal blooms, as a potential pathway for contaminants from the watersheds to the coastal ocean, and perhaps the beaches.

57 SATELLITE VIEW OF STORMWATER RUNOFF PLUMES IN SOUTHERN CALIFORNIA

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Spatio-temporal dynamics of stormwater plumes is being studied in different coastal zones of the Southern California Bight using SeaWiFS and MODIS satellite imagery. The total volume of precipitated water is a primary factor regulating plume size. This relationship is quantitatively different in different regions, and can be explained by the differences in watershed size, terrain, and land-use. The direction of plume propagation results from the near-shore circulation. In particular, during spring transition typical to California Current System, equatorward currents associated with wind-driven upwelling can transport stormwater plumes downcoast. The most pronounced plumes, characterized by high concentration of suspended inorganic matter, were observed within two-three days after rainstorms; later color shifts in the plumes indicate the presence of phytoplankton biomass resulting from their response to the nutrient loading of the plumes.

58 THE EFFECTS OF STORMWATER RUNOFF IN SANTA MONICA BAY

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Urbanization within the Los Angeles region has resulted in increased stormwater inputs to the coast. Stormwater runoff creates distinct plumes that are easily detected by their low salinity and high turbidity signatures. Several aspects of these plumes have been studied, such as increases in contaminants and human pathogens, but few studies have attempted to directly test the links between stormwater plumes and changes in the phytoplankton community. Shifts in the phytoplankton community have great potential to alter the functioning of coastal foodwebs. In addition, it is unknown how long and far these stormwater plumes may travel once they are formed, thus their effects may extend well beyond their local discharge region. During recent storm events, we collected water samples of stormwater from Ballona Creek and from several sites within Santa Monica Bay. The samples were analyzed for their nutrient concentrations, bio-optical properties, and phytoplankton composition. Nitrate concentration, total suspended solids, and colored dissolved organic matter were high in stormwater samples (approximately 35 um, 46 mg l^{-1}, and 3.9 relative fluorescence units, respectively). In addition, preliminary analysis of phytoplankton samples from several sites within the bay revealed the presence of several potentially toxic species including *Pseudonitzschia* sp., *Dinophysis* spp., *Amphidinium* sp., *Cochlodinium* sp., and *Lingulodinium polyedrum.*

59 HARMFUL ALGAE IN THE SOUTHERN CALIFORNIA BIGHT: PRESENT THREATS AND FUTURE CONCERNS

David A. Caron, Astrid Schnetzer, Rebecca Schaffner, Steffi Moorthi, Peter Countway, Beth Stauffer, Adriane Jones, Diane Kim and Billy Pan. Department of Biological Sciences, University of Southern California, 3616 Trousdale Parkway, Los Angeles, CA 90089-0371.

The coastline of southern California has not been immune to the perceived increase in the occurrence of harmful algal blooms in coastal waters globally. Resident harmful algae in the Southern California

Bight include species of the dinoflagellate genus *Alexandrium* (a source of PSP) and the diatom genus *Pseudonitzschia* (a source of domoic acid). Most notably, blooms of *Pseudonitzschia* spp. and outbreaks of domoic acid toxicity have occurred in the Bight during the last five years. These outbreaks have lead to significant mortality events for marine mammals and coastal bird populations. In addition to these known problems, occasional blooms of a variety of potentially harmful algae occur in the Bight, including dinoflagellates in the genera *Lingulodinium, Cochlodinium, Dinophysis* and *Prorocentrum.* These algae have the potential for toxin production but as yet none has been attributed to these species in local waters. *Lingulodinium polyedrum,* in particular, has caused massive (but thus far inocuous), red tides along the coast of southern California, and 'nuisance blooms' of species within the prymnesiophyte genus *Phaeocystis* have begun to appear. This talk will provide a brief overview of the known and potential problems facing coastal waters of southern California, and outline potential causes and concerns raised by the presence and increased frequency of these events.

60 *PSEUDONITZSCHIA* AND DOMOIC ACID IN THE LOS ANGELES HARBOR AND ADJACENT COASTAL WATERS

Astrid Schnetzer, David A. Caron, Peter E. Miller, Rebecca Schaffner, Adriane Jones, Diane Kim and Billy Pan, Department of Biological Sciences, University of Southern California, 3616 Trousdale Parkway, Los Angeles, CA 90089-0371. Stephen Weisberg, Southern California Coastal Water Research Project, Westminster, CA 92683

The Los Angeles harbor and adjacent coastal ocean have proven as a 'hot zone' for *Pseudonitzschia* and domoic acid over recent years. Since 2003, the region has become the focal point of several research efforts to investigate these toxic blooms. The impact that episodic river discharge into the San Pedro Bay may have on *Pseudonitzschia* growth and toxin production is the focal point of an ECOHAB program that encompasses a 400 km^2 study area from the Palos Verdes peninsula to Newport Beach. This area is periodically influenced by runoff from the Los Angeles River, San Gabriel River and Santa Ana River. Multiple surveys have been conducted to investigate the temporal and spatial relationship between nutrient input via river discharge as well as coastal upwelling and *Pseudonitzschia* abundance and domoic acid concentrations. We will present some of the findings from this research and discuss the environmental factors that may play a key role in the development of toxic events within the coastal waters off Los Angeles and Orange Counties.

61 DOMOIC ACID TOXICITY IN CALIFORNIA SEA LIONS (*ZALOPHUS CALIFORNIANUS*) STRANDED IN ORANGE COUNTY, CA, 2002–2006

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Domoic acid, a biotoxin most commonly produced by diatoms in the genus *Pseudonitzschia,* has sickened or killed more than 250 California sea lions at the Pacific Marine Mammal Center in Orange County, CA since 2002. Affected animals characteristically are in good body condition, exhibiting seizures, tremors, disorientation, ataxia, head-weaving and/or a combination of these symptoms. Common pathological lesions associated with domoic acid intoxication will be discussed and illustrated.

62 DOMOIC ACID POISONING IN SEABIRDS

Susan Kaveggia. International Bird Rescue Center, 3601 South Gaffey Street, San Pedro, CA 90731

There was no confirmation or documentation that domoic acid affected birds until 1991. In September of that year large numbers of ill Brown Pelicans and cormorants were observed along the California coast. Shortly thereafter the etiology was connected to the recent algae bloom of *Pseudonitzschia australis.* Since then there has been an alarming increase in domoic acid poisoning among the avian species. Little is still understood about the pathology between domoic acid and seabirds. A brief discussion of this subject will cover symptoms, treatments, and post-mortem findings that have been elucidated in the past few years.

63 RED TIDE BLOOMS (*LINGULODINIUM POLYEDRA*) IN SAN PEDRO BAY

Ivona Cetinic, Astrid Schnetzer, David A. Caron and Burt Jones. Department of Biological Sciences, University of Southern California, Los Angeles, CA 90089 USA

During the period from March to September 2005, phytoplankton abundance, and physical and chemical parameters were measured at 5 stations in surface and subsurface chlorophyll maximum in San Pedro basin as a part of the ECOHAB study. During that time, large red tide blooms were observed, dominated by HAB dinoflagellate *Lingulodinium polyedra*. Evolution of the phytoplankton community in the water column of the coastal ocean may be driven by a combination of natural and anthropogenic processes. Some of the measured environmental variables driven by the mentioned processes, when coupled to observed blooms, point out possible triggers of red tide bloom initiation in San Pedro Bay.

64 THE WATER QUALITY TASK FORCE IN REDONDO BEACH; HOW A SMALL COASTAL CITY IS DEALING WITH RED TIDES AND FISH KILLS

Chris Cagle. Councilman, City of Redondo Beach, 415 Diamond Street, Redondo Beach, CA 90277

Clean water is one of the keys to maintaining the health, safety and the economic well-being of residents, businesses and visitors. As a coastal community with a harbor, beaches and regional storm water facilities, Redondo Beach has unique challenges to protecting surface waters and ocean quality. Redondo Beach Councilman Chris Cagle will share his City's experience with Red Tides and the effect it has had on their harbor. He will explain what his community is doing about it and the work in progress of their Water Quality Task Force. He will also describe a community volunteer program being set up to deal with fish kills resulting from reoccurring Red Tides in King Harbor.

65 SOME ASPECTS OF MONITORING FOR TOXIC AND NONTOXIC BLOOMS (THE HABS AND THE HAB-NOTS) IN CALIFORNIA

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California has the distinction of having the longest established monitoring program for paralytic shellfish poisoning (PSP) in the U.S., dating back to 1927. The traditional monitoring method employed by all states has relied on the analysis of bivalve shellfish samples for the presence of one or more known toxins. In the fall of 1991 domoic acid was identified in Monterey Bay. In response, the California Department of Health Services began analyzing samples for this toxin and concurrently developed a volunteer-based phytoplankton monitoring program as a potential early warning tool. Establishment of the phytoplankton monitoring program has resulted in the early detection of both toxic and non-toxic blooms as well as the quick determination of the causative organisms. This information has proven valuable for health officials responsible for managing toxic events and for informing the public about visible blooms. A review of the shellfish PSP toxicity data reveals a seasonal pattern with distinct periods of elevated toxicity. Analysis of this data in conjunction with remote sensing information and phytoplankton distribution and abundance data provides interesting new insight into potential environmental cues for toxigenic blooms. There is also tremendous variability in PSP toxin levels and spatial distribution from year to year. Analysis of domoic acid data also reveals a seasonal pattern of peak toxicity. Domoic acid concentrations in shellfish from nearshore monitoring sites have increased dramatically since 2000. The majority of *Pseudonitzschia* blooms, with the resultant increase of domoic acid levels in shellfish, have occurred between Santa Cruz and Los Angeles.

66 GOALS AND OBJECTIVES OF CALIFORNIA'S SEDIMENT QUALITY OBJECTIVES PROGRAM

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The State Water Resources Control Board is developing sediment quality objectives and implementation policy for enclosed bays and estuaries. The two greatest hurdles associated with the development of sediment quality objectives are the limited ability to link sediment chemistry concentrations to

biological impairment and the uncertainty associated with currently available tools and indicators. As a result sediments cannot be assessed, managed or regulated using the single line of evidence approach traditionally used in water quality programs. Instead this program will rely on a multiple line of evidence approach to make station level and station network assessment decisions. The goals of this program are to 1) establish a condition that is considered protective, and then develop, refine and validate the tools so that the condition of each station can be measured relative to the protected condition and 2) use multiple lines of evidence to assess the condition of sediment and 3) promote consistency and minimize the reliance on best professional judgment.

67 COMPARISON AND SELECTION OF SUBLETHAL SEDIMENT TOXICITY TESTS FOR USE IN EVALUATING SEDIMENT QUALITY

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The use of aquatic invertebrates for acute sediment toxicity testing to assess sediment quality is widespread and well standardized. Sublethal tests have the potential to detect effects at lower levels of contamination than acute tests. Sublethal toxicity tests have been developed for many different aquatic species, yet little is known about their comparability and reliability. The objective of this study was to identify a suite of sublethal toxicity tests that are reliable, ecological relevant, with diverse endpoints and exposure conditions. Several tests were investigated for their the sensitivities, comparability and applicability in a variety of situations. Six of the sublethal tests; (amphipod, *Leptocheirus plumulosus* 28-day survival, growth and reproduction; polychaete, *Neanthes arenaceodentata* 28-day survival and growth; benthic copepod, *Amphiascus tenuiremis,* 14-day life-cycle; seed clam, *Mercenaria mercenaria* 7-day growth; lysosomal destabilization using the oyster, *Crassostrea virginica*; and sediment-water interface testing with embryos of the mussel *Mytilus galloprovincialis*) were compared. The sublethal tests varied in their relative sensitivity and they were not always more sensitive to the sediments than the acute tests. More information regarding the presence of sediment toxicity was usually gained by using the acute and sublethal tests in concert, compared to using either type of test alone. The *Neanthes arenaceodentata* 28-day survival and growth or sediment-water interface testing with embryos of the mussel *Mytilus galloprovincialis* were recommended as sublethal tests for assessing sediment quality.

68 A MEASURE OF BENTHIC INVERTEBRATE COMMUNITY CONDITION FOR CALIFORNIA BAYS AND ESTUARIES

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An indicator of benthic community condition that combines four existing benthic index approaches was developed for California bays and estuaries. Habitat-specific versions of five benthic indices were developed for two soft-bottom benthic habitats. In each habitat, performance of the indices was evaluated individually and in combination using independent data rated by nine benthic ecologists. The five index approaches were based on (a) community measures, (b) presence, abundance and pollution tolerance of several species, or (c) mixtures of (a) and (b). A four-index combination (Benthic Response Index (BRI), Index of Biotic Integrity (IBI), Relative Benthic Index (RBI) and River Invertebrate Prediction and Classification System (RIVPACS)) had the highest accuracy and was selected as the indicator of benthic condition. This combination correctly classified as affected or unaffected 91.7% of the evaluation samples from the southern California euhaline bays habitat and 100% from the polyhaline San Francisco Bay habitat. The indicator was developed only in these two habitats because sufficient data for indicator development were available only here. Future indicator development in other habitats is anticipated once additional data are collected.

69 DEVELOPMENT AND EVALUATION OF CHEMICAL SQGS BASED ON BENTHIC MACROFAUNA RESPONSES TO SEDIMENT CHEMISTRY

Kerry J. Ritter*, Steven M. Bay, and Robert W. Smith. Southern California Coastal Water Research Project, Westminster, CA

Resource managers often rely on chemical indicators referred to as sediment quality guidelines (SQGs) to assist them in assessing the level of sediment contamination in our coastal waters. SQGs are typically derived from large data sets containing paired chemistry and toxicity data. However, calibrating SQGs to toxicity data, such as the survival of amphipods, to various contaminant concentrations in the sediment may not accurately reflect how benthic macrofauna, indigenous to the specific region or area, respond to the same chemical profiles. For example, some studies have shown that benthos may be more sensitive to anthropogenic impact than toxicity. In our presentation we consider the effectiveness of current SQGs for predicting the state of benthos and quantify some of the differences in responses between benthos and amphipod survival with regard to different chemical concentrations. Finally we present an alternative chemical SQG specific to predicting the state of benthos in marine sediments.

70 DEVELOPMENT AND VALIDATION OF A MULTIPLE LINE OF EVIDENCE FRAMEWORK FOR INTEGRATING SEDIMENT QUALITY DATA

Steven M. Bay*, Stephen B. Weisberg, and Jeff Brown. Southern California Coastal Water Research Project, Westminster, CA

Many assessment frameworks have been developed for the characterization of sediment quality, most of which are based on the sediment quality triad of sediment contamination, toxicity, and impacts on resident biota. These multiple line of evidence approaches have been used extensively in site-specific assessments, but they are typically based on best professional judgment. This is difficult to replicate and is therefore problematic for applications such as sediment quality objectives that must be standardized across a wide variety of sites. A framework for integrating multiple lines of evidence (LOE) in a standardized manner was developed for use in California's sediment quality objectives program. The framework is composed of three steps: classification of each LOE into one of several categories based on response magnitude and certainty, integration of the LOE categories to evaluate the potential for chemically-mediated impacts and the severity of biological effects, and a final step of assigning an impact category to the data. The framework was validated by comparing the results for a subset of stations to the assessment obtained based on the best professional judgment of individuals with extensive sediment quality assessment experience. There was a high level of agreement between the impact category for a station obtained using the framework and the consensus category obtained using best professional judgment. The error rate in classification using the framework was similar to that present among professionals and there was no evidence of bias.

71 CITIZEN MONITORING STATUS AND TRENDS

Erick Burres. State Water Resources Control Board

Surface water quality continues to be major issue across the state and the nation. The great threat is non-point pollution. Citizen monitoring can and has addressed both data and pollution reduction. The Clean Water Team is the State Water Resources Control Board's citizen monitoring program. This presentation will give an introduction to citizen monitoring, its history within California, an update on current activities and its future roles.

72 CITIZEN VOLUNTEER BASED BENTHIC MACROINVERTEBRATE WATER QUALITY SAMPLING

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The San Diego Stream Team (SDST) is a citizen volunteer based non-profit organization that conducts benthic macroinvertebrate sampling for water quality analysis using the Southern California Index of Biotic Integrity. The SDST identifies valued characteristics, the status and trends of biological resources in and around the aquatic environment, and evaluates the effects of various land uses on water quality. This presentation will give an overview of the history of the SDST and examples of the challenges and achievements of citizen monitoring.

73 RECOVERY OF THE WESTERN SNOWY PLOVER AT SAND'S BEACH, COAL OIL POINT RESERVE, SANTA BARBARA, CALIFORNIA

Jennifer Stroh. Santa Barbara Audubon Society & University of California's Natural Reserve System, Santa Barbara, California

The Western Snowy Plover (SnPl) is a small, threatened shorebird. The coastal population roosts and breeds on sandy beaches throughout the west coast from southern Washington to Baja California, Mexico. Habitat destruction and increased human recreation on these beaches have caused their dramatic decline over the past few decades, leading to their protection under the Endangered Species Act in 1993.

Throughout its range, the SnPl depends on particular sites such as wide, flat beaches around river mouths or estuaries, and beaches that are backed by sand dunes and supplied with kelp. Sand's Beach, part of Coal Oil Point Reserve (COPR), is one of these sites. Due to habitat degradation and disturbance, SnPls had abandoned Sand's Beach as a breeding site in the late 1970's, but would return every year during the winter. Active management was implemented for SnPl conservation in 2001. Five years later, over 400 SnPls winter at Sand's Beach, double the number found when the program began. During spring and summer, one can observe up to 25 nesting pairs. COPR is first to demonstrate that breeding SnPls may recover when appropriate management is applied. COPR SnPl management includes restoration, fencing, signage, and a docent program. Disturbance research indicates that the recovery would not have occurred without volunteer docents. SnPl Docents are crucial for the protection of SnPls through friendly contact and education of beach users. By promoting public awareness, docents increase the effectiveness of other management efforts, such as signs and barriers. These combined management tools have made it possible to maintain beach access and recreation for the public while preserving habitat for the SnPls.

74 RAPID ACQUISITION OF CITIZEN SCIENTIST DATA ACROSS LARGE DISTANCES: GRUNION GREETERS AND THE INTERNET ALONG THE CALIFORNIA COAST

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Now in its fifth year, the Grunion Greeter Project involves citizen scientists monitoring sandy beaches throughout California for the elusive grunion, *Leuresthes tenuis.* Hundreds of volunteers attend workshops each year to learn how to observe this beach spawning fish during the peak season. We coordinate the project with our web site, www.Grunion.Org, in several ways. First, the site provides basic information about grunion and our citizen scientists, with links to news articles, photographs, and other media. Second, we recruit volunteers and show dates of training workshops, community partnerships, and detailed flyers. Third, after training, volunteers sign up for observations at specific times on designated beaches by using a password-protected pull-down menu. For each date, county and beach site, numbers of volunteers are displayed live, permitting individuals to determine where they are needed up to the time of monitoring. Fourth, the site contains an interactive questionnaire that Grunion Greeters complete after each observation, prompting input on the numbers of fish seen, any predators, weather and wave descriptions, and other comments, stored in an electronic database. Fifth, we post bi-weekly web updates throughout the grunion season with photographs and quotes from the Grunion Greeters, beach workers, and others, providing rapid feedback and a common experience between the different areas of the state. Finally, questions, comments, and results are rapidly exchanged via e-mail. This use of high-tech web-based communication allows centralized rapid, consistent data acquisition from many observers over a large geographic area. Funded by California Sea Grant College, NFWF, and NOAA.

75 A THREE YEAR STUDY OF SEASONAL BACTERIAL CONCENTRATIONS USING VOLUNTEER ASSISTANCE

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Freshwater outlets in southern California, such as channelized rivers and storm drains, often have bacterial concentrations that exceed health standards, particularly after rain events. The goal of this study was to organize volunteer help in order to determine how bacterial concentrations of freshwater outlets influenced coastal waters. Sampling focused mainly on the Los Angles River, its receiving waters of Long Beach Harbor, and adjacent recreational beaches. From 2003 to 2005, samples were collected seasonally and after the first flush (> 0.5 inches rainfall) for total coliforms, *E. coli,* and enterococcus. Results revealed that coastal waters were subject to high levels of bacteria, with the extent of contamination varying among years. Distinct wet and dry patterns in bacterial concentrations were seen with the largest number of stations in exceedance of health standards occurring during the first flush. Health exceedances occurred during all wet weather sampling at 25 to 100% of the sites. Exceedances were also detected during three dry weather sampling events. Freshwater outlets into coastal waters showed plume-like effects over all three years, with high bacteria concentrations that abated as increased salinity and mixing occurred. Bacterial concentrations 1.5 miles offshore from the Los Angeles River were detected in exceedance concentrations during the every first flush. Volunteers made an important contribution to this study by collecting samples and reduced the total project cost. This study demonstrates the successful integration of volunteers in a multi-year study to collect needed data on seasonal and yearly variation of bacterial concentrations effecting coastal recreational waters.

76 FIRE-FLOOD-FISH: LOSS AND PERSISTENCE OF UPPER SANTA ANA RIVER SPECKLED DACE (*RHINICHTHYS OSCULUS*) IN SOUTHERN CALIFORNIA AND THE VALUE OF TIMELY HUMAN INTERVENTION

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The advent of unusually extensive fires (10/21–11/4, 2003) followed by excessively damaging floods in 2003–04 in the upper Santa Ana River watershed stimulated discussions in resource agencies and the Southern California Native Freshwater Fauna Working Group about the advisability of fish rescue. In October 2004 Santa Ana speckled dace were taken from 3 streams (Plunge, Lytle, Cajon) and placed in the care of Kerwin Russell of the Riverside-Corona Resource Conservation District, By this time significant flooding had already occurred in two other streams (City and Strawberry/Twin) where dace seemed to have been extirpated. Dace have persisted in the first three streams from which reserve populations were taken, but recent efforts to locate them in the other two heavily flooded streams have failed. Evidence of dace presence in all of these streams immediately prior to floods is presented. Debate continues on the advisability of reintroducing dace where extirpated. Historical and recent data is presented on patterns of fire, precipitation, flood and sedimentation intensity, and the nature of the habitat, geomorphology and anthropogenic events in the five stream basins to determine possible reasons for loss or retention of populations. Less, or non-fire/flood impacted streams were also examined. Fishes were only eliminated at sites with record peak flows, not rainfall, following 95% watershed burn.

The Working Group, which meets quarterly at Cal Poly University Pomona, provides an informal forum for individuals from agencies and academia to reach consensus on conservation and other issues.

77 TOOTH FRACTURE AND WEAR COMPARED IN A RANCHO LA BREA SABER-TOOTHED CAT AND THE DIRE WOLF

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Several extinct carnivores preserved in the Pleistocene Rancho La Brea deposits display a high incidence of teeth broken during life as compared with modern species. This might reflect greater

prey consumption in the Pleistocene relative to the present. This possibility was considered in a previous study on *Canis dirus* which explored tooth fracture and wear between two localities at Rancho La Brea, in which significant differences were found. In this study, we compared tooth fracture frequencies and tooth wear in a different carnivore, *Smilodon fatalis.* Unlike many species of canids, felids tend to feed entirely on meat. We were interested in how a hypercarnivore would compare to a canid in terms of tooth wear and breakage, as canids may eat harder diets including items such as bone. Our results indicated that while *S. fatalis* fractured their teeth about a third more often than in a comparison locality, the difference was not significant. They did not exhibit heavier tooth wear either. This was a departure from the *C. dirus* data, and supports the likelihood of a difference in diet between the two species. In order to be sure that the age distributions of the two species are similar, and to eliminate the possibility of an age effect, we estimated individual age *S. fatalis* from pulp cavity dimensions of lower canine teeth. Like the *C. dirus* sample, pulp cavity analysis indicated no significant difference between pits in the age structure of the preserved populations.

78 EFFECTS OF OFF-HIGHWAY VEHICLE ACTIVITY ON THE MOJAVE DESERT BIOTA

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The frequent use of off-highway vehicles (OHV) within the eastern Mojave Desert may lead to the destruction of plant and animal habitats. The effects of OHV activity on the eastern Mojave Desert community were investigated by measuring the percent coverage of perennial plants and vehicle tracks, and the abundance of lizards and ant nests. OHV active areas were compared with protected National Park Services (NPS) land, which is closed to OHV activity. Measurements were taken over two days at two separate sites along an access road that divides protected land from land open to OHV activity. Community composition on both sides of the road was similar, validating a comparison between the sites. Six line transects (100 m in length) at each site were used to measure the percent coverage of vehicle tracks and perennial plants. The abundance of lizards and ant nests was measured with belt transects (10 m wide and 100 m long). All two tailed t-tests between open and closed sites showed no significant differences for the measurements taken. The NPS land is recovering from past OHV use; the land has been protected since 1994, making the measured NPS and OHV sites both disturbed communities. The data were in the predicted direction yet no significance could be determined. However, future studies of broader regions may show an effect of OHV activity on the desert biota.

79 LATE CENOZOIC VOLCANISM NEAR BAKER, CA

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Late Cenozoic volcanism in the eastern Mojave Desert, near Baker California, spans 13 million years. The earliest event from 12.8 to 13.0 Ma resulted in the emplacement of a hypabyssal sill of rhyolitic to trachydacitic composition. This was followed at 12.1 Ma by multiple flows of trachyandesite (pyroxene andesite), approximately 15 km to the west in the Halloran Hills. The most recent activity began about 7.5 Ma and has continued to the Holocene. The result has been trachybasalts (hawaiites) and basaltic trachyandesites (mugearites) of the Cima volcanic field. This study analyzed over 100 rock samples from three areas for 21 major, minor and trace elements. The data define a trend of high $K_2O + Na_2O$ rocks that show minimal decease in alkalis with decreasing silica content over time. Trace elements analyses for some of the pyroxene andesites and many of the basalts reveal that crustal contamination has played a role in their current geochemistry.

It is suggested that Cenozoic volcanism began during initial stages of late Miocene detachment and has continued to Recent time as upwelling asthenosphere has occupied the void created by the thinning lithosphere. The compositional variations reflect progressively deeper melting, from shallow crustal rhyolite and trachydacite to lower crustal pyroxene andesite, to lithospheric and asthenospheric mantle basalts. While past researchers have stressed the role of MORB-like partial melts generated from an underplated East Pacific Rise (EPR), this research suggests the volcanism is most likely a manifestation of crustal thinning and not directly related to subduction of the EPR.

80 THE EFFECT OF FEMALE CRICKET CHEMICAL CUES ON THE AGGRESSIVE BEHAVIOR OF MALE CRICKETS, *ACHETA DOMESTICUS*

Leslie J. Buena and Sean E. Walker. California State University, Fullerton

Male house crickets, *Acheta domesticus,* show aggressive behavior to gain opportunities for mating events over other males. Female cricket chemical cues along with residency status should influence male aggression. I predicted that aggression would increase with higher levels of female chemical cues. Resident males should be more likely to exhibit aggression in the presence of female cues than in their absence. I observed male behavior in 14 cm × 26 cm containers with a sand substrate. These containers had previously housed zero females, one virgin female, two virgin females, or three virgin females for 48 h prior to trials. More encounters occurred when there were chemical cues from three females than from zero, one, or two females. Resident males showed more aggression and had more wins as female chemical cues increased. I also found that the intensity of aggression could be predicted based on the age of resident and intruder males. Older residents and younger intruders were more likely to be aggressive. These data suggest that perceived resource value is an important factor influencing a male's decision to fight. I believe that male crickets are more active when they perceive high resource value and are more willing to take the risks that come with engaging in aggressive encounters when benefits outweigh the cost. The data also suggest that age and residency status may be important, influencing factors. This pattern may be a product of younger intruders having nothing to lose and the cost of territory loss for older residents.

81 WATER AND SEDIMENT QUALITY EVALUATION OF THE SANTA CLARA RIVER ESTUARY–ANALYSIS OF IMPACTS ASSOCIATED WITH THE DISCHARGE OF TREATED WASTEWATER

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The City of San Buenaventura currently discharges a monthly average of approximately 7 mgd of tertiary treated effluent into Santa Clara River estuary. The discharge has been ongoing for approximately 45 years. The objective of this study was to evaluate whether chemicals in the effluent may be affecting water and sediment quality within the estuary. Extensive testing with a variety of both marine and freshwater species showed a low incidence and degree of toxicity, and limited exceedences of water quality criteria. The discharge generally did not appear to be associated with toxicity; causes of toxicity appeared to be localized, variable, and related to upstream sources or groundwater influence. The sediment quality evaluation indicated that contaminants of concern were generally below sediment quality guidelines, and most of the responses in the sediment toxicity tests were related to coarse substrate. Copper is a primary constituent of concern for the treatment plant based on frequent exceedence of current marine water quality criteria. However, relationships between copper and toxicity, in addition to a series of water-effect ratio (WER) studies suggest that concentrations of copper in both the WWTP discharge and estuary are below those of potential biological concern.

82 COMPARATIVE ANALYSES OF THE ENTIRE MITOCHONDRIAL *cox*-I GENE SEQUENCE ACROSS VARIOUS GENERA OF CHITONS

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Chitons (Polyplacophora) are very ancient and morphologically conservative members of Mollusca, characterized by having eight shell plates, a creeping foot, and radular teeth coated with magnetite. Sequence comparisons of partial mitochondrial cytochrome *c* oxidase subunit I (*cox*-I) gene sequence are extremely popular and thousands have already been obtained for chitons, but there are few studies where the entire gene has been sequenced for a selection of closely related genera. In ongoing studies, we are attempting this for a broad selection of the 90 genera of living chitons with the goal of investigating how this protein subunit is free to vary within chitons. We expect that a comparative analysis of the inferred COX-I amino acid sequences will reveal where natural modifications have survived the continuous process of natural selection, presumably without altering any critical COX-I function. Humans and other animals also have this gene and it is well known that amino acid mutations within a conserved region can result in developing genetic disorders within the human body. Variation within COX can lead to human disorders specifically mitochondrial disorders (providing energy for organelles) such as myoglobinuria, thus, we expect that chiton *cox*-I could serve as an appropriate model for understanding the protein in general. By designing new PCR primers that amplify between the sequenced *cox*-I portion and adjacent mitochondrial genes we have already obtained complete *cox*-I sequences for selected chitons and are presently expanding this sampling of genera.

83 SEX DIFFERENCES AND GEOGRAPHIC VARIATION IN BODY SIZE IN THE WOLF SPIDERS *RABIDOSA RABIDA* AND *RABIDOSA PUNCTULATA* (ARANEAE: LYCOSIDAE)

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Spiders are a classic example of sexual dimorphism and numerous hypotheses have been put forward to explain the extreme sexual size dimorphism seen in some species. However, little work has evaluated geographic variation in sex differences in spiders. Utilizing specimens from museum collections and from our own collections in Texas and Ohio, we examined variation in carapace width, chelicerae length, and the length of leg I and IV in two different species of wolf spider, *Rabidosa rabida* and *Rabidosa punctulata. Rabidosa rabida* and *R. punctulata* are two closely related species that occur in old-field habitats and both forage from vegetation. We found significant differences in body-size between sexes, locations in both species. Females were generally larger than males, and spiders collected in Texas were larger than those from Ohio. In addition, there was a significant difference in sexual dimorphism across locations in *R. punctulata.* Females of the species are much larger than males in Texas and females are not significantly larger than males in Ohio. We also examined chelicerae size, a characteristic associated with prey capture, in both species. After controlling for size differences, females generally had larger chelicerae than males and in *R. rabida* there is a larger sex difference in chelicerae size in Texas when compared to Ohio. In *R. punctulata,* females have larger chelicerae than males but there are no differences among locations. Our results indicate that different populations of the same species can be different in their degree of sexual dimorphism.

84 DIFFERENTIAL EFFECTS TO DOPAMINE OXIDATION IN PC12 CELLS AND PRIMARY ASTROCYTES: A MODEL FOR NEURODEGENERATION?

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Among the various neurodegenerative diseases that affect many people, one that is gaining more recognition is Parkinson's disease. It is the destruction of the substantia nigra that leads to the progression and development of this disease. What is killing the neurons in the substantia nigra? The main culprits are reactive oxygen and nitrogen species (ROS and RNS). Looking at Parkinson's disease from a biochemical standpoint, observations support the generation of ROS and RNS by a marked increase in the presence of superoxide dismutase and a decrease in glutathione (GSH). The oxidative state of the substantia nigra leads to the accumulation of free radical generators, like iron, low antioxidants, and damage and/or inhibition of complex I, through the production of ROS and RNS.

While exposing PC12 cells and primary astrocytes to varying concentrations of dopamine, results from MTT viability assay established the physiological concentration used in future experiments. There was no change in astrocyte viability, but an inverse relationship between PC12 cell viability and dopamine concentration. Data support the notion that in a co-culture system, astrocytes not only cope with the stress associated with dopamine but also protect the PC12 cells either through uptake and/or breakdown of dopamine, or through the release of GSH to prevent oxidation. This is evident by an increase in PC12 cell viability when placed in a co-culture system. As a consequence of protecting the PC12 cells, the astrocytes up-regulate iNOS. Despite the occurrence of NO toxicity, this is incomparable to the harmful effects of dopamine oxidation.

85 PLEISTOCENE STRATIGRAPHY AND PALEOENVIRONMENT OF BAHIA SAN QUINTIN, BAJA CALIFORNIA, MEXICO

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A previously undescribed Pleistocene marine sedimentary deposit around Bahia San Quintin (Baja California, Mexico) was described and mapped to begin to reconstruct the paleoenvironment and the nature and the sequence of the depositional events.. This unit is unique in that it is extraordinarily rich in fossils and has sedimentary structures that indicate dynamic coastal processes related to changing sea level and the volcanic origin of the bay over the past 180,000 years. Using stratigraphic data and preliminary maps of the area an interpretation of the paleoenvironment has been constructed. The purpose of this study is to test the hypothesis that these sediments may be a record of the Sangamon Interglacial high stand of sea level.

86 EVALUATION OF ECOLOGICAL AND HYDROLOGICAL CONDITIONS IN THE SANTA CLARA RIVER ESTUARY WITH RESPECT TO DISCHARGE OF TREATED EFFLUENT

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The purpose of this study was to identify areas in which the discharge of treated wastewater to the Santa Clara River Estuary may enhance beneficial uses. Key components of this study included evaluation of changes in habitat type and community assemblages over time, as well as changes in hydrological function. The estuary supports a number of species of regulatory interest, including the federally listed tidewater goby (*Eucyclogobius newberryi*). Moreover, it is located in a semi-arid region of California that has been subjected to intensive habitat and water development over time, making it problematic to establish baseline conditions. The ecological investigation relied on extensive historical information including USGS maps, aerial photographs, and anecdotal accounts from a variety of sources. Analysis of aerial photographs demonstrated that there were minimal changes in the relative composition of habitat types between 1929 and 2002. Most changes in flora and fauna could be attributed to development of the floodplain that has resulted in a decrease in estuary size of approximately 90%. The hydrological analysis used historical data, anecdotal evidence, and modeling to develop estimates for monthly flows under natural conditions. This analysis showed that the discharge accounts for a portion of the river flows that would historically have reached the estuary, but which have been diverted for other uses upstream. Overall, the analysis indicated that the discharge supports beneficial uses of the estuary, particularly by maintaining water quality and habitat.

87 TIERED AQUATIC LIFE USES FOR SOUTHERN CALIFORNIA COASTAL STREAMS

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The Los Angeles Regional Water Quality Control Plan identifies beneficial aquatic life uses and sets water quality standards to protect them based on the type of organisms present in a water body, i.e. cold water fish, estuarine species, etc. Tiered Aquatic Life Uses (TALU) is another approach to assigning habitat beneficial uses. The TALU framework tailors aquatic uses for a particular ecosystem by identifying tiers of use based on an analysis of (1) what aquatic life ***is*** present and (2) what ***could be*** there, i.e. what is the highest attainable use. The highest attainable use is set based on examination of historical conditions and healthy reference sites. Science, public input, and the regulatory agencies' priorities combine to determine goals for each water body. There are many potential benefits of TALU. By assigning beneficial uses more precisely, regulatory agencies can protect high quality waters and flag vulnerable waters where the biological condition is good but where significant stressors are present. Identification of these stressors may lead to prescriptions for improvement. TALU allows regulators to set more realistic goals for degraded waters and encourage incremental improvements. A TALU framework for southern California is being developed by USEPA, the LA Regional Water Quality Control Board, and an advisory group of aquatic ecologists. This project links to two USEPA initiatives: (1) *Use of Biological Information to Better Define Designated Aquatic Life Uses in State and Tribal Water Quality Standards: Tiered Aquatic Life Uses,* and (2) *Designated Use Plan,* demonstrating how a region can tailor the national model to local conditions.

88 DETAILED COMPOSITIONAL COMPARISON OF ACIDIC NSO COMPOUNDS IN BIODEGRADED VERSUS NON-BIODEGRADED ENVIRONMENTAL SAMPLES USING NEGATIVE ION ELECTROSPRAY FOURIER TRANSFORM ION CYCLOTRON RESONANCE MASS SPECTROMETRY

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Knowledge of compositional changes due to crude oil biodegradation currently comes from geochemical research of oil reservoirs—not from surface contamination. Acidic NSO compounds, such as phenols and acids, have been used as indicators of microbial alteration. If these compounds provide evidence of biodegradation in the oil reservoir, one can infer that they may also provide clues to biodegradation in surface environments. Here we compare the compositional changes of acidic NSO compounds in a crude oil before and after biodegradation in the environment using ESI FT-ICR MS. Negative ion ESI allows for the selective ionization of acidic compounds while FT-ICR MS affords high enough resolution for a detailed analysis of a complex environmental sample. Crude oil contaminated soil samples were collected from an active biozone. In the non-degraded crude oil, nitrogen-containing compounds (e.g. N, N_2, NS, NO) comprised ~70% of the total relative ion abundance. Among these, carbazole-like compounds (N-containing compounds) accounted for ~50% of the relative abundance. In the more degraded crude oil samples, oxygen-containing compounds dominated the mass spectra. These surface samples are likely the most biodegraded as the bacteria have ample supplies of oxygen and nutrients added to facilitate bioremediation. For the most shallow samples, O_2-containing compounds accounted for 55–60% of the total relative ion abundance—a ~50% increase from the non-degraded oil. As the degree of oxygenation increased, the relative abundance of nitrogen-containing compounds decreased by a factor of 5 (to ~10%). Consequently, the relative abundance of NO-containing compounds increased by a factor of 2.

89 EFFECTS OF SALINITY CONCENTRATION ON RATES OF POLYP CLONING, GROWTH, AND STROBILATION IN THE *AURELIA LABIATA* (CNIDARIA, SCYPHOZOA)

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The purpose of this study was to determine how increased and decreased salinity concentrations affect the developmental asexual stage in the life cycle of the *Aurelia labiata.* This species of jellyfish is known to be adaptable in the changing marine environments of coastal and harbor ecosystems, but environmental factors could influence their reproduction rates. After culturing from fertilized eggs, 10 similarly developed polyps on settlement plates were suspended in closed system tanks having salinity concentrations of 2.5%, 3.5% (control), and 4.5%. Four overlapping trials of 9–12 weeks were conducted, two using a freshwater base and two with a seawater base. Observations were made weekly and recorded onto templates of each plate. Results in the trials with a freshwater base were inconclusive due to unexpected distress and detachment losses of the control polyps, resulting in the decision to conduct two other trials with a seawater base and RO water. In the seawater based trials, all polyps in the 2.5% and 3.5% salinities survived and formed colonies. The rate of cloning, colonizing, strobilation and release of ephyrae was faster in the 2.5% salinity than in the control group, proving my hypothesis wrong that rates would be slower. No polyps in the 4.5% salinity level survived the lengths of the trials, as was expected. Results indicate that a lower salinity induces polyp cloning and strobilation. Investigating salinity ranges in the field where *Aurelia* are found, and salinity effects in combination with other environmental variations such as effects of increased ocean absorption of CO2 (higher acidity) would be subjects of further research.

90 ASSESSMENT OF THE SELF-PURIFICATION OF A CONSTRUCTED WETLANDS AND THE EFFECTS OF POLLUTION ON THE BIOLOGICAL COMMUNITY

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In a world where life thrives on water, it is important to have methods that will secure the quality of water and provide the nourishment that the environment requires. In this study we observed the effects of pollution on a constructed wetland to determine the wetland's ability to reduce pollution levels. Through chemical tests and biological surveys, we were able to determine our wetland's efficiency in pollution reduction. Through chemical testing we found pollution reduction levels of up to twenty percent for phosphate, six percent for nitrate, one hundred percent for iron and ninety-two percent for copper. From the biological surveys taken, the bacterial counts and average diversity showed a substantial increase after the introduction of pollution. The protist population initially showed a substantial drop in numbers followed by a notable increase. Our research has proven that the constructed wetland has the ability for self-purification.

91 A PRELIMINARY STUDY OF PLASTICS POLUTION IN THE COASTAL WATERS AND BEACHES OF BAJA CALIFORNIA PENINSULA

ESTUDIOS PRELIMINARES DE CONTAMINACIÓN POR PLÁSTICOS EN AGUAS COSTERAS Y PLAYAS DE LA PENÍNSULA DE BAJA CALIFORNIA MÉXICO

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A study was conducted of the coastal waters and beaches from Ensenada Baja California to La Paz Baja California Sur, during the months of November and December 2005. The goal of the study was to assess the concentrations of plastics in Mexican waters and on Mexican beaches. Beach sediment samples were taken by hand, and zooplankton samples by manta trawl on board the ORV Alguita. Plastics were found all along the Baja California Peninsula including some beach areas that are considered as natural reserves, were minimal human activity is supposed to take place. The point origin of most of these plastics is most likely nearby populated areas, but point of origin of some of these plastics is much farther away

Se realizó un estudio por las costas de la península de Baja California desde las costas de Ensenada, hasta La Paz Baja California Sur, durante los meses de Noviembre y Diciembre del 2005. El objetivo de esta investigación fue obtener una idea de las concentraciones de plásticos presentes en aguas y playas mexicanas. Se llevo acabo diversos muestreos a lo largo de las aguas y playas de la Península de Baja California, a través de muestreos de zooplancton y de sedimentos de playas a bordo de la embarcación ORV Alguita. Se encontraron rastros de plásticos en todas las estaciones a lo largo de la península de Baja California, inclusive en algunas zonas asignadas como reservas ecológicas, en las cuales la actividad humana es mínima.

92 ANGLING-INDUCED BAROTRAUMA AND INITIAL CATCH SURVIVAL OF SOUTHERN CALIFORNIA NEARSHORE AND SHELF ROCKFISHES (SCORPAENIDAE, *SEBASTES* SPP.)

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Minimum size limits have not been considered a practical management tool for rockfishes because most rockfish suffer decompression injury (barotruama) and positive buoyancy upon capture. However, little documentation exists regarding whether barotrauma in rockfishes is fatal. We collected nearshore and shelf rockfishes by hook-and-line in southern California between 18–177 m depth to characterize external and internal signs of barotrauma by species and depth, and to quantify initial survival 10 min after capture. The most common signs of barotrauma occurring in 166 rockfish (21 species) were subcutaneous gas (70%), hemorrhage (64%), and stomach eversion (63%). The incidence and extent of barotrauma was species-specific with species caught in deeper water (>58 m) generally showing a higher incidence of 4 or more traumas than species caught shallow (<58 m). Overall capture survival (n = 145) was 68%; however, species-specific survival generally did not decrease with depth. Of species with a sample size greater than 10, halfbanded rockfish (*Sebastes semicinctus*), flag rockfish (*Sebastes rubrivinctus*), and vermilion rockfish (*Sebastes miniatus*) showed the highest survival (>87%), while rosy rockfish (*Sebastes rosaceous*) and olive rockfish (*Sebastes serranoides*) showed the lowest (<10%). The majority of rockfish showing signs of barotrauma survived, suggesting that evidence of barotrauma upon capture is not necessarily an indication of rockfish mortality. Assuming rockfish can be rapidly released back to the depth of capture, the potential for post-release survival may be greater than previously thought.

93 CAN MEDICAL STUDENTS LEARN AND RETAIN BEDSIDE ULTRASOUND? THE EVALUATION OF A FOURTH YEAR MEDICAL STUDENT ELECTIVE IN EMERGENCY ULTRASOUND

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While bedside ultrasound (BUS) has been incorporated into residency training in Emergency Medicine and has become an asset to emergency departments (ED) across the country, current U.S. medical school curriculum offers limited ultrasound training. In 2002, UC Irvine established the first medical student rotation in BUS in the ED. Through this rotation we tested whether or not medical students were able to learn and retain ultrasound skills. To complete this study, each student was given a thirty-five question test with an interactive DVD prior to and at the end of their rotation, as well as six months after the completion of their rotation. The test was also administered to a control group of students at the same time intervals without prior training. Over a nineteen-month period we enrolled 25 two-week rotation students and 20 four-week rotation students. When data analysis was complete, the mean pre-test score (PreTS) for all rotators was 46.9%, the mean Post-Test Score (PostTS) for all rotators was 75.7% ($p < 0.005$). The mean PostTS for the two-week students was 71.7%, while the four-week students scored 80.9% ($p = 0.003$). The mean scores on the 6-month follow-up exam were 69.1% for the two-week rotators, while the four-week rotators scored 76.9% ($p = 0.008$). The control group PreTS and PostTS were similar to the PreTS of the rotators ($p = 0.42$). The difference between the pre and post-test for the control group was not significant ($p = 0.116$). This study indicates that medical students can learn and retain BUS techniques through a structured rotation.

94 ECTOPARASITES OF THE CALIFORNIA SCORPIONFISH, *SCORPAENA GUTTATA,* IN THE SOUTHERN CALIFORNIA BIGHT

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It is unclear to what degree parasites cause stress to their host and what long term damage occurs to host physiological responses. Chronic stress can inhibit an organism's normal physiological response to the environment. The California scorpionfish, *Scorpaena guttata,* is common in the Southern California Bight (SCB) and is frequently infested with ectoparasites. Of the 216 individuals sampled throughout the SCB, 210 were parasitized for an overall prevalence of 97.2% with an overall mean intensity of 48.2. This host harbored as many as eight species of parasites ranging in prevalence from 0.5%, *Elthusa californica* (Isopoda: Cymothoidae) to 88.4%, *Lepeophtheirus rotundipes* (Copepoda: Caligidae). The mean intensity of individual parasite species on *S. guttata* ranged from 1.0, *Holobomolochus spinulus, E. californica,* and *Elthusa vulgaris* (Copepoda: Bomolochidae, Isopoda: Cymothoidae, respectively) to 54.3, *Naobranchia scorpaenae* (Copepoda: Lernaeopodidae). The range of intensity of the parasitic copepod *N. scorpaenae* was from 0 to 321 individuals on a single fish. It was not uncommon to find fish with more than 100 individuals of this copepod parasitizing the gill filaments. The prevalence of *N. scorpaenae* at 78.2% was equally prominent. *Naobranchia scorpaenae* is a lernaeopodid copepod that is highly adapted to attach to the host's gill filaments using its modified maxilla. Most of the individuals recovered in this study had visible blood in the gut, presumably from the host's gill tissue. Infestation levels of ectoparasites were compared from scorpionfish collected at various predetermined stations in southern California, including those collected near wastewater outfalls.

95 MICROSATELLITE DNA ASSESSMENT OF MULTIPLE PATERNITY IN THE VIVPAROUS ROCKFISH *SEBASTES MELANOPS*

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Three polymorphic microsatellite loci are being optimized and employed in a natural population of the viviparous Pacific rockfish *Sebastes melanops* to determine if multiple paternity occurs in brooded females, and to quantify the incidence of female mating behaviors. Brooded females of *S. melanops* ($n = 14$) were collected from nearshore reefs off Oregon to genotype mothers and samples of their brooded offspring (zygotes, embryos or larvae). DNA was extracted from three females and their progeny (n = 90 per female), amplified by PCR, and assayed by polyacrylamide gel electrophoresis using a Li-COR DNA sequencing system. A one-sire null hypothesis (female monogamy and full-sibling relationships among brooded progeny) is being tested by conducting paternal allele counts and examining Mendelian segregation patterns in observed versus expected genotypic offspring ratios for the one-sire model. Early results of genotyped progeny from the first fully assayed female revealed four paternal alleles at one tetranucleotide- repeat locus, and three paternal alleles at a pentanucleotide-repeat locus; both loci revealing evidence of at least two fathers and polyandry in S. *melanops.* Brooded females of brown rockfish, *S. auriculatus,* from Washington and rosy rockfish, *S. rosaceus,* starry rockfish, *S. constellatus,* and greenspotted rockfish, *S. chlorosticus* from southern California have also been collected for future tests of multiple paternity across the species-rich genus *Sebastes.*

96 THE INFLUENCE OF ARTICHOKE THISTLE ON HUMMINGBIRD POPULATIONS

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Artichoke thistle (*Cynara cardunculus* L.), an invasive plant species disrupting coastal southern California, has been competing with rare, native plants in recent years. Hummingbirds feed on the artichoke thistle's large purple inflorescences, however preliminary observations suggested that hummingbird nests built on these plants often fail. It was hypothesized that hummingbird nesting success on live artichoke thistles would be lower than on native vegetation, mainly due to plant tensile strength. Nest searches and data collection were carried out from April to June, 2004 and May to July, 2005. A total of 59 active nests were found, all on artichoke thistle. Species using the nests were Costa's hummingbirds (*Calypte costae*), Anna's hummingbirds (*Calypte anna*), and Black-chinned hummingbirds (*Archilochus alexandri*). Thirty-eight nests were built on the dead stalks or inflorescences of artichoke thistle, and 21 nests were built on live artichoke thistle leaves. Approximately 24% of all nests were successful, which was within normal values presented in previous publications. Leaf and stem strength tests revealed that all nest locations were strong enough to hold a nest with two young, plus the mother. Failure of nests built on dead thistle was largely due to predation, but not to plant strength alone. In contrast, failure of nests built on live thistle was hypothesized to be mainly due to plant strength and structure combined with nest placement, predation, and extreme temperature. Although artichoke thistle disturbs native plant species, it may ultimately provide a benefit for hummingbirds as both a nectar source and a nesting source.

97 A RETROSPECTIVE ANALYSIS OF GALLBLADDER PATHOLOGY USING BEDSIDE ULTRASOUND

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The objective of this research was to determine if emergency department (ED) sonographers could use bedside ultrasound scans (BUS) to determine gallbladder pathology. Pigmented and cholesterol based gallstones are thought to be the cause of most gallbladder conditions resulting in right upper quadrant pain. Both cholelithiasis, indicating gallstones within the gallbladder, and choledocholithiasis, indicating the presence of gallstones within the common bile duct were visualized using BUS. This study retrospectively reviewed 37 consecutive months of ED gallbladder BUS at a Level I trauma center. The ED Ultrasound Process Improvement Committee (EDUPIC) reviews all BUS to ensure proper BUS diagnoses. BUS results were compared to the EDUPIC and radiology results, and the EDUPIC results were compared to radiology as well. Of the 1690 gallbladder BUS that met the study's inclusion criteria, 575 received radiological imaging. When compared to the EDUPIC, sonographers were 88% sensitive (95% Confidence Interval [CI], 85–90) and 97% specific (95% CI, 95–98). When compared to radiology, sonographers were 88% sensitive (95% CI, 84–91) and 87% specific (95% CI, 82–91). The EDUPIC interpretation was 90% sensitive (95% CI, 87–93) and 90% specific (95% CI, 85–93) when compared to radiology. The results indicate ED sonographers are both sensitive and specific in the diagnosis of gallstones. These results also suggest that patients do not need to be subjected to the biological hazards resulting from CT scan radiation. Additionally, patients can benefit from a quicker and less expensive alternative when compared to radiological imaging, the most common modality for determining gallbladder pathology.

98 EUPHAUSIID SWARMS IN THE MONTEREY SUBMARINE CANYON AS SAMPLED WITH A REMOTELY OPERATED VEHICLE

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Euphausiids in the Monterey Submarine Canyon routinely form aggregations often exploited by numerous predator species. Our study examined influences of advection and variability in the species composition of euphausiid swarms at the shelf-break. In situ observations made in June, July and November, 2001 and August, 2002 with a Remotely Operated Vehicle permitted precise location of sampled swarms. Dominant euphausiid species were *Euphausia pacifica* and *Thysanoessa spinifera.* We observed significant overlap of their populations near the shelf-break, including dramatic variations in swarm species composition over small spatial scales (hundreds of meters), and over short time scales at the same location (daily). These observations, as well as moored acoustic data from a 12-day deployment at the shelf-break suggest the importance of advective mixing of krill populations at this location. Influence of advection on the fine-scale distributions of krill was also indicated by acoustic scattering layers 1–5 m thick along the periphery of tidal flow maxima. These unique observations emphasize the importance of resolving plankton ecology at fine scales in dynamic shelf-break environments, where multiple species of this critical trophic level overlap.

99 EFFECTS OF ALTERED SALINITY DURING INCUBATION ON CALIFORNIA GRUNION, *LEURESTHES TENUIS*

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From early spring to late summer, California grunion (*Leuresthes tenuis*) ride with the high tides onto the shores of Southern California to spawn. The female fish dig into the sand and deposit their eggs, while the males deposit their milt around the females to fertilize the clutches. The clutches of eggs remain out of water incubating in the sand until the next high tide, synchronized with the lunar cycle. Although there are considerable advantages to non-aqueous egg incubation, there are also potential disadvantages, one of which is possible changes in osmolarity in the surrounding medium. The effects of different salinity levels on grunion eggs during incubation were experimentally tested, by comparing the embryo survival and hatching competence of eggs incubated in sand moistened with artificial seawater of five different salinities, including normal seawater at 34 ppt, and water of 15, 24, 41, and 49 ppt. Each set of grunion eggs were tested for hatching competence in two different hatching media: normal sea water and the salinity of incubation. Grunion embryos tolerated decreased salinity better than increased salinity during incubation, and hatched at significantly lower rates when the salinity was above normal. The hatching medium did not alter hatching competence of eggs within each treatment. This study has potential implications for possible effects on grunion for implementation of desalination plants on the coast, because after desalinization, concentrated seawater is released into the ocean. Funded by California Sea Grant College and Pepperdine University.

100 RELATIONSHIPS BETWEEN BODY SIZE AND SOUND PRODUCING STRUCTURES IN CRICKETS:DO BIG MALES HAVE BIG HARPS?

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The conspicuous acoustic signals of crickets are used to attract mates and to deter potential rivals. As such, there may be correlations between indicators of male quality or fighting ability (e.g. body size) and male signals. These are created when a male cricket closes his wings rapidly and a file and scraper mechanism cause an area of the wing called the harp to vibrate. Since the harp acts as a mechanical resonator, increases in harp area will result in decreases in the frequency of sound produced. If there is a positive relationship between harp area and body size, this would provide a mechanism which explains the often found correlation between body size and carrier frequency. We examined this in four different species of cricket, *Acheta domesticus, Gryllus bimaculatus, Gryllus rubens,* and *Teleogryllus oceanicus.* For each species we measured pronotum width as an index of body size, tibia length, and the area of the whole forewing and of the harp. There were significant differences among species in their morphological characteristics. In all but one species, tibia length, wing area, and the area of the harp were significantly correlated with body size. However, as body size increased harp area did not increase proportionally. This was expected because, in most species, females exhibit strong stabilizing selection on the carrier frequency produced by males and might constrain the evolution of structures involved in male signaling. In conclusion, our data provide a potential mechanism linking decreases in song frequency with body size in male crickets.

101 LINKING THE STATOLITH CHEMISTRY OF *APLYSIA CALIFORNICA* TO WATERSHED DISCHARGE PLUMES ALONG THE OPEN COAST

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Biologists must identify the larval dispersal trajectories of marine organisms inhabiting marine protected areas (MPAs) in order to understand recruitment variability and population connectivity. Currently larval trajectories from populations inhabiting southern Californian MPAs, typically 2–3 km in length, remain unknown. However, the use of calcified structures such as fish otoliths and invertebrate statoliths as natural tags has enabled tracking of some marine larvae. Prior research indicates that along the open coast tags might exist at spatial scales of 10s of kilometers. We propose to validate whether or not watershed discharge plumes generate detectable watershed-specific tags at a spatial scale (<10 km) relevant for tracking larvae from MPA populations in southern California. In October 2005, we out-planted egg-masses of a model invertebrate species, *Aplysia californica,* at three MPA sites influenced by watershed discharge plumes along the open coast of southern California. Concurrently at each site, seawater chemistry, temperature and salinity were sampled to correlate statolith chemistry to seawater characteristics. Statoliths and seawater samples will be analyzed for elemental concentrations by inductively coupled plasma-mass spectrometry (ICP-MS) at the University of California Santa Barbara in July 2006. We predict that the out-planted *A. californica* statoliths will have watershed-specific tags. If detectable tags are validated, *A. californica* could be used in future studies as a model species to track larval dispersal among MPAs along the open coast of Southern California. Further, environmentally induced natural tags may be useful to track larval trajectories in other spatially close (<5 km) areas influenced by watershed discharge.

102 PHYLOGENETIC STUDY OF THE FLATFISH GENUS *PLEURONICHTHYS*

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The genus *Pleuronichthys* consists of seven species of right-eyed flatfishes found in the Pacific Ocean, five found of the coast of southern California. Although these fishes have been included in several family and order level phylogenetic studies, the relationships of the species within the genus are often incomplete and unresolved. I have attempted to gain better phylogenetic resolution by focusing specifically on the genus as the ingroup. I have collected seventy-four measurements and ten counts for all seven species in the genus as well as for seven pleuronectid outgroup taxa. I used gap coding to obtain discrete characters and a multiple outgroup approach to polarize the data. Using parsimony analysis, I generated trees using ordered and unordered characters. Ordering the characters yielded a tree with a monophyletic ingroup, a consistency index (CI) of 0.558 and a retention index (RI) of 0.6571. The unordered characters resulted in a similar tree (CI = 0.740, RI = 0.561) with two main differences: the placement of *Pleuronichthys cornutus* and the rooting of the tree. The resolved trees and implications of the differences between them will be discussed.

103 AN *IN VITRO* RISK ASSESSMENT MODEL FOR THE IMPACT OF PESTICIDES ON THE DEVELOPMENT OF T CELLS IN C57BL/6 MICE

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Environmental toxicants, such as pesticides, have had severe consequences on the environment and the organisms that live in it. Although the effects of many pesticides on the reproductive system have been thoroughly studied, few scientists have tackled the study of their effects on the immune system.

These studies are important because statistics have shown that today children are more prone to develop asthma and allergies compared to 10 years ago. The consensus among immunologists is that this is due in part to environmental influences on their developing immune systems, including during gestation. Previous studies of pesticides on the development of the immune system utilized gross assays of immune function, like cell counts and static immunophenotyping. We have undertaken the development of an accurate, sensitive *in vitro* risk assessment model for the effects of environmental toxicants on the development of the immune system. Our risk assessment model assays the consequences of prenatal pesticide exposure on the development of T cells. Our methodology uses day 16 or 17 embryos from C57BL/6 pregnant mice. Harvested thymocytes are exposed *in vitro* to combinations of antibodies that have been shown to induce the differentiation of thymocytes into mature T cells. Different concentrations of pesticide are added to the cells in the presence or absence of antibodies. Flow cytometric analysis is used to determine the phenotype of the resulting T cells. We have selected the pesticide methoxychlor as the first pesticide for analysis based on its established role as an endocrine mimic and known immune-endocrine interactions.

104 DETECTION OF QUORUM-SENSING COMPOUNDS IN PLANT-ASSOCIATED MICROORGANISMS

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The mechanism known as quorum sensing (QS) is an environmental sensing system that allows bacteria to monitor their own population density and to couple cell population density with gene expression. Genes transcribed in response to QS mechanisms are diverse and involved in bioluminescence production, antibiotic biosynthesis, plant nodulation, biofilm formation, exopolysaccaride biosynthesis, and production of virulence factors, among others. In Gram-negative bacteria, most but not all, of the autoinducers belong to the family of N-acylhomoserine lactones (AHLs). In the last decade, a considerable amount of QS compounds (or autoinducers) has been detected in plant-associated bacteria. Most of these studies have been carried out with bacteria isolated from roots of temperate legumes. As far as we know, there are no screenings regarding the production of QS compounds on microsymbionts isolated from tropical plants. AHLs compounds are signal molecules and produced in very low concentrations. Therefore, they cannot be detected by chemical methods. The general aim of this work was to detect QS compounds in plant-associated bacteria from the tropics. We will show results about the use of different types of biosensors to detect AHL activity in supernatants of the bacterial strains.

105 THE USE OF MICROSATELLITE MARKERS TO EVALUATE THE GENETIC POPULATION STRUCTURE OF THE ROUND STINGRAY AT SEAL BEACH, CA

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Round stingrays (*Urobatis halleri*) are small, benthic elasmobranches with a range from Eureka, CA to Panama with high abundance in southern California. Most of the 500 stingray related injuries that occur annually during summer months are attributed to this particular species and the venomous barb located at the base of the tail. As part of an ongoing project to increase our knowledge about these animals, round stingrays were sampled monthly by beach seines from Seal Beach, CA from August of 2004 to December of 2005. Microsatellite markers were used to determine if the population at this location was the same year round, or if there were population shifts as previous tagging data have suggested. Out of 2,183 tagged stingrays, only 13 were recaptured within 1 km of Seal Beach. Thus far, one polymorphic microsatellite marker has been developed (Uha 170), and 28 different alleles have been recovered from the Seal Beach population over the sampling period of about 1.5 years. The allele frequencies for this locus show no major changes during the sampling period ($F = 0.72$, $p = 0.65$). We are in the process of developing new markers to strengthen our data set which suggests that the *Urobatis halleri* population is stable over time. We are also continuing our sampling during 2006, and we will present these data as well.

106 GSNO FORMATION IN ASTROCYTES AND NEURONS-IMPLICATION FOR NEUROTOXICITY

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S-nitrosoglutathione (GSNO) has been proposed to function as a modulator of the action of NO. GSNO has potentially significant roles in cell signaling and biological process through S-nitrosylation of proteins and modulation of redox status of cells by altering the GSH pool. To investigate GSNO formation under conditions that mimic NO production by iNOS during inflammation, we exposed primary astrocytes and cortical neurons to a long acting nitric oxide donor (DETA-NO), and measured GSH, GSNO and GSSG by HPLC. Exposure of both astrocytes and neurons to DETA-NO showed formation of GSNO and GSSG. Comparison of GSH/GSNO and GSH/GSSG ratios in both astrocytes and neurons showed both ratios decreased with increasing concentrations of DETA-NO. However, decreases in GSH/GSNO and GSH/GSSG ratios were more dramatic in neurons than in astrocytes, thus indicating a difference in rates of GSNO metabolism and GSSG reduction. Subsequently, the activities of GSNO and GSSG reductase were measured and compared. The activity of both the GSNO reductase and GSSG reductase in astrocytes were significantly higher than in neurons. Analysis of GSNO consumption in neurons and astrocytes by HPLC also showed a subsequent increase in the formation of GSSG. Taken together, the data suggest that the glutathione defense system in astrocytes is an efficient defense against nitrosative stress. This is especially important in the context of neurodegenerative disease associated with neuroinflammation where there is selective loss of neurons concomitant with a long lasting activation of iNOS.

107 GLUTATHIONE TRANSFERASE ACTIVITY IN 3 SPECIES OF SEA TURTLES, *CHELONIA MYDAS AGASSIZII, LEPIDOCHELYS OLIVACEA,* AND *CARETTA CARETTA,* FROM THE BAJA CALIFORNIA PENNISULA

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Sea turtles, all species of which are critically threatened or endangered, exhibit different dietary preferences based on life stage and species. Exposure to various toxicants may vary and require different detoxification strategies. Glutathione conjugation is an important detoxification mechanism for halogenated organic compounds which may be anthropogenic or natural. We examined the kinetics of basal glutathione transferase (GST) activity in liver tissue from 3 species of sea turtles—the herbivorous Eastern Pacific green, known locally as black (*Chelonia mydas agassizii*) and the carnivorous olive ridley (*Lepidochelys olivacea*) and loggerhead (*Caretta caretta*). Preliminary data suggest higher basal GST activity in *C. caretta* relative to the other species. Additionally, enzyme kinetic parameters (K_m and V_{max}) for glutathione, as well as the relative affinity (V_{max}/K_m) of GST for this substrate seem higher in *L. olivacea* than in *C. mydas.* These results suggest a possible difference in GST activity among species and may indicate a potential relationship between detoxification mechanisms and trophic level. Future research will include further examination of GST kinetics in sea turtles species, quantification of body burden of halogenated toxicants, and investigation of the biotransformation of natural halogenated products of dietary origin.

108 FIREBREAKS AND INVASIVE PLANT SPECIES

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Firebreaks are used by fuels management programs to stop, suppress or control fire behavior by manipulating plant in order to prevent costly damage. Previous studies have linked firebreaks to the establishment of nonnative invasive plants as a result of changing light levels, hydrology, and nutrient levels. Invasive species increase in abundance when an area is mowed or ploughed as a result of rapid growth rates and increased seed production which create persistent seed banks. The establishment of nonnative invasive plants within fuel treatments is a serious concern within the Whittier Hill-Puente

Hill corridor because treated areas abut intact coastal sage scrub stands. We established belt transects across fire break/coastal sage scrub interfaces in order to examine the effect of fire breaks on cover, growth, seed production and seed banks of non-native species. We predict that non-native species will show increased growth rates and increased seed production in the firebreaks, and that seedbanks will be greater in firebreaks as a result. We also predict that the penetration of non-natives into coastal sage scrub will be related to the seed production and seedbanks present in adjacent fire breaks. Increased seed sources in a firebreak adjacent to coastal sage scrub may make coastal sage scrub more susceptible to invasion following large scale disturbance such as natural or prescribed fires. This is of particular concern because prescribed fires have been proposed as an alternative method of fuel control in the Whittier-Puente Hill Corridor.

109 AN OBSERVATION OF OYSTER SETTLEMENT OVER SEASONS FOR THE WEST COAST OYSTER, *OSTREA CONCHAPHILA*

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Declines in populations of the native oyster, *Ostrea conchaphila,* have piqued recent interest in restoring its populations. Local population dynamics and persistence are influenced by the magnitude and timing of larval settlement. Thus, we examined factors such as temperature and salinity, which may influence larval settlement and examined settlement as a function of season. *O. conchaphila* settlement is thought to peak in the spring and fall months in California and Baja. Salinity and temperature vary in estuaries due to rainfall, freshwater input, distance from open ocean, oyster exposure to air temperature and water depth of oyster settlement. Salinity and water temperature ranges are crucial for adult survival and cue synchronized male spawning during reproduction. To observe variation in larval settlement density over seasons, artificial substrate tiles were placed in two separate estuarine locations in Newport Bay, CA and Carlsbad, CA. Temperature was monitored at each site every 15 minutes and salinity was measured by hand with a salinity probe at each tile collection. Tiles were collected and oyster settlers counted every two weeks during spring tides to pinpoint pulses in settlement. Preliminary results indicate that settlement is significantly higher at Newport Bay than at Aqua Hedionda only when pulses in settlement occur, and larval settlement is variable among months.

110 AN APPLICATION OF ISLAND BIOGEOGRAPHY THEORY TO RIPARIAN RESTORATION

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The theory of island biogeography says that species diversity on an island is controlled by its size and distance from the mainland. If a degraded landscape can be thought of as an "ocean" inhospitable to many species, restored and natural areas provide "islands" of habitat. If island biogeography theory applies to habitat restoration, there should be a relationship between species diversity at a restored site and its distance from the nearest established site. At five southern California riparian restoration sites, transects were used to measure plant species richness. The closest upstream established site to the restoration was located using a combination of fieldwork and aerial photographs. Distance between this site and the restoration ("site distance") was measured and a regression analysis of distance vs. species richness per meter transect length (S/m) was performed. The S/m vs. site distance regression yielded a significant negative relationship ($p = 0.04$) once seasonality and landscape factors were taken into account. These findings are tentative due to small sample size but, if confirmed, will have implications for restoration planning.

111 PETROLOGY AND GEOCHEMISTRY OF THE BIG PINE VOLCANIC FIELD, INYO COUNTY, CALIFORNIA

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The Big Pine volcanic field encompasses 1000 square kilometers of the northern Owens Valley. It is comprised of 30 basaltic cones and flows emplaced over the past 1.2 million years.

In thin section, Big Pine (BP) basalts display marked differences. Some samples contain phenocrysts of plagioclase, resorbed olivine and orthopyroxene and minor nepheline. Others have abundant plagioclase and pyroxene phenocrysts, but sparse olivine and no nepheline. There is also a noticeable difference in phenocryst size. Some basalts are comprised of phenocrysts that exceed 1mm in diameter, while others have much smaller (<0.1mm) phenocrysts. There is no apparent relationship between phenocryst size and mineralogy.

Major element analyses support thin section observations. Two distinct groupings are present. One is generally quartz normative (silica-rich), while the second is nepheline normative (silica-poor). Temporal relationships are difficult to establish, but field observations suggest the older flows were more silica undersaturated. Trace element data is enigmatic. There is a subtle trend for the more incompatible elements to favor silica-rich rocks; however, strontium is clearly anomalous.

The bimodal distribution of silica has been well documented for the Cima basalts. There, it is attributed to systematic variation in melting depth over time. A similar explanation for the BP field is difficult to rationalize. BP basalts were emplaced over a shorter time span and display an inverse relationship, characterized by more recent silica-rich basalts. We conclude BP mineralogy and geochemistry are best explained by partial assimilation of Mesozoic granite as basaltic magma rose upward from the underlying mantle.

112 REAL-TIME OCEANOGRAPHIC MONITORING NEAR POINT FERMIN AND THE LOS ANGELES RIVER MOUTH

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The ocean is a constantly changing environment that impacts both local and global communities. Currently, a majority of the ocean measurements are made as a snapshot (one time and location) that potentially leaves out vital changes. High-resolution monitoring is used to gather data on small temporal scales (i.e. minutes) over a long period and is essential for tracking short-term impacts from both natural and man-made causes, such as a pollution spill or storm. The Center for Integrative Coastal Observation, Research and Education (CICORE) program's goal is to monitor California coastal waters and shores and they have recently added two moorings that are operated through the California State University Long Beach. One mooring is in cleaner ocean water at the edge of the continental shelf and the second mooring is near the terminus of the Los Angeles River. The purpose of the project is to measure oceanographic data, sampling at high data rates (minutes), and make it available in real-time on the web. The two moorings will permit us to observe and measure variable conditions in the River and compare them to a more natural site. A third mooring in the San Gabriel River is planned for later this year. Standard measurements are collected at six-minute intervals at a depth of around 1.5 m from the surface. This data is available to scientists, managers, and students of all ages to better understand the both short-term and long-term trends of these coastal waters.

113 THE EFFECTS OF SELECTIVE FISHING PRESSURE ON THE POPULATION DYNAMICS AND LIFE HISTORY PARAMETERS OF THE CALIFORNIA SHEEPHEAD, *SEMICOSSYPHUS PULCHER*

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The California sheephead *Semicossyphus pulcher* is a hermaphroditic wrasse which presents an interesting challenge in environmental management due to its harem mating system and protogynous life history pattern. The fishery for California sheephead is size-selective, and while the recreational fishery has historically targeted larger males, the more recent live-fin fishery specifically targets small immature females for the restaurant trade. It is uncertain whether these practices affect the timing of sexual changeover or alter the natural harem mating system. California sheephead populations were surveyed at five sites with varying degrees of fishing pressure, and fish were collected for age and growth analysis. Three mainland sites (Rocky Point, the Ridges and the Los Angeles Federal Breakwater) and two Santa Catalina Island sites (Italian Gardens and West Quarry) were sampled in 2005–2006. There were significant differences in density, sex distribution, sex ratio and mean fish size of California sheephead populations among the five sites. However, while mean density was significantly higher at the two island sites, mean fish size was significantly lower at those two sites, as well as at the Ridges, the Palos Verdes site falling outside of the restricted commercial fishing area. In addition, sex distribution at the two island sites and the Ridges was significantly different from the two other mainland sites, showing a greater concentration of small male fish and a lower female-to-male ratio. While further sampling is needed, this suggests that fishing pressure as well as biogeography may have an effect on California sheephead population structure.

114 CHANGES IN DENSITIES OF FECAL INDICATOR BACTERIA (FIB) OVER DIFFERING TIDAL FLOWS IN THE BALLONA WETLANDS, LOS ANGELES

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There are two main objectives of this experiment: 1) to create a mathematical model showing the relationship between turbidity, dissolved oxygen, pH, salinity, time from high tide, and levels of indicator bacteria for fecal contamination, and 2) to see if fecal indicator bacteria (FIB) densities differ with tidal flows from flood to ebb.

In the field samples were tested at a single location every half hour during 12-hour periods on 3 occasions for temperature, dissolved oxygen, and pH levels using the YSI 600R Sonde Electronic Probe. In the laboratory, turbidity was measured using a HACH 2100N turbidity meter, and densities of FIB (total coliforms, *E. coli,* enterococci) were determined using IDEXX Quantitray 2000 test kits and reagents based on enzyme substrate methods. A mathematical model was created showing the relationship between dissolved oxygen, turbidity, pH, salinity, time from high tide, and bacterial growth.

Results indicated that bacterial levels were higher with decreased dissolved oxygen, decreased salinity, and increased turbidity in a neutral pH. As bacterial levels rose, the dissolved oxygen and salinity reserves were depleted. Turbidity levels appear to increase as sediments are drawn off of the banks of the water column and resuspended from the bed of the creek. FIB appear to attach to the sediment particles, thus are drawn into the water as turbidity increases. FIB levels were also higher at and around high tide. This study suggests that sophisticated mathematical models can be constructed to integrate testing parameters. As more v ariation around these parameters is explained through modeling, then fewer key parameters could be measured in the future, thus reducing the costs for monitoring programs.

115 USING SOLID-PHASE MICROEXTRACTION TO DETERMINE THE BIOAVAILABILITY OF PYRETHROID INSECTICIDES IN SEDIMENT

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Pyrethroid insecticides are widely used in both agricultural and urban regions, and their use will become even more widespread as organophosphate compounds are being phased out. Pyrethroid insecticides have broad-spectrum aquatic toxicity, including acute toxicity to benthic organisms. Recent detections of pyrethroid residues in sediments in many California surface streams and estuaries underline pyrethroids as an important class of emerging contaminants. However, because pyrethroids are highly hydrophobic, it may be argued that the total concentration of pyrethroids in the sediment does not reflect actual biological exposure, as a significant fraction of the pyrethroid may be adsorbed to the solid phase and is thus unavailable. In this study, solid phase microextraction (SPME) was used to determine the bioavailability of sediment-bound ^{14}C-Cyfluthrin to benthic invertebrates. Disposable polydimethylsiloxane (PDMS) fibers were inserted directly into the sediment phase where they acted as "biomimetic" devices for *C. tentans.* PDMS fiber measurements correlated well with ^{14}C-Cyfluthrin body residue in *C. tentans,* indicating that these fibers may be good surrogates for this species ($R^2 = 0.92$, $p = 0.0002$). The contribution of sediment consumption to the bioavailability of cyfluthrin to *C. tentans* was also investigated. Results were variable ($\alpha = 0.69$–3.50), most likely due to the low radioactivity used in this study. Current experiments are underway that include higher levels of radioactivity which should decrease variability. In the future, PDMS fiber measurements will also be correlated with LC_{50} values to further establish the use of PDMS fibers as a robust method to predict the bioavailability and toxicity of sediment-bound pyrethroids to benthic invertebrates. This method will be useful in risk assessment and monitoring studies.

116 ENANTIOSELECTIVE INHIBITION OF ACETYLCHOLINESTERASE BY CHIRAL ORGANOPHOSPHORUS INSECTICIDES

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A majority of chiral pesticides are introduced into the environment as racemates even though pesticidal activity often results from preferential reactivity of only one enantiomer, with the other becoming an added chemical burden to the environment and potentially toxic to non-target organisms. Chirality often enters in the reaction mechanisms of these compounds. Organophosphorus (OP) insecticides are a popular class of pesticides. Its major mode of action is the inhibition of Acetylcholinesterase (AChE) leading to disruption of nervous function. Several OPs contain a chiral center, either in the pentavalent phosphorus, or a carbon or sulfur substituent of the phosphorus atom. Studies on the differences in bioactivity between enantiomers of a chiral pesticide are still limited. This study investigates the enantioselectivity in AChE inhibition of chiral OPs. Separation and isolation of enantiomers were carried out on HPLC using a chiral column. Preliminary results from *in vitro* inhibition tests using Eel AChE suggest differences in toxicity between the (+) and (−) enantiomers of profenofos, fonofos and crotoxyphos. AChE inhibition assays following 24-hour exposure of *Daphnia magna* to racemates and enantiomers indicated differences in AChE inhibition between the (−) and (+) enantiomers that is consistent with acute toxicity results. Reduction in AChE activity was higher in (−) enantiomer with IC50 values of 0.006, 0.115, 0.029 μmole/L for profenofos, fonofos and crotoxyphos, respectively. IC50 values for the (+) enantiomers of the same OPs are at concentrations higher than the IC50 of the racemates.

117 AN ANOLE LIZARD (SQUAMATA: POLYCHROTIDAE) PRESERVED IN COLOMBIAN COPAL

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The remains of an anole lizard, preserved in Colombian copal, were investigated using conventional X-ray techniques, computed tomography (CT) scanning, radiocarbon dating, and digital photomicrography. The X-rays revealed transverse processes on the autotomic caudal vertebrae, identifying the specimen as a β-anole. The results of the CT scan proved inconclusive, and radiocarbon dating yielded an approximate age of $<$ 50 years. Digital photomicrographs indicate that the specimen probably represents the extant species *Norops tropidogaster.*

118 SYNTHETIC POLYMERS IN THE MARINE ENVIRONMENT; WHAT WE KNOW–WHAT WE NEED TO KNOW

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Synthetic Polymers, commonly known as plastics have been entering the marine environment in quantities paralleling their level of production over the last half century. (Thompson) Thirty years ago the prevailing attitude of the industry was that "plastic litter is a very small proportion of all litter and causes no harm to the environment except as an eyesore."(Derraik) Since that time, US consumption of thermoplastics has sextupled (Center for Environmental Education), and litter is now 60–80% plastic, whether on land or in the marine environment (Plastic Debris Rivers to Sea Project). While undoubtedly still an eyesore, plastic debris is now having significant harmful effects on marine biota. Albatross, fulmars and petrels mistake floating plastics for food and few, if any, individuals of these species remain unaffected; in fact, 44% of all seabird species ingest plastic. Sea turtles ingest plastic bags, fishing line and other plastics, as do 26 species of cetaceans. (Derraik) The numbers of fish, birds mammals, and other marine organisms that succumb each year to derelict fishing nets and lines in which they become entangled is not reliably known, but estimates in the millions have been made (Moore)

Ready ingestion of degraded plastic pellets and fragments (EPA) raises toxicity concerns since they are known to sorb hydrophobic pollutants (Moore, Takada). At least four common plastic additives are known estrogen mimics, however no studies have yet determined if any of these toxics desorb when ingested and become bioavailable (Andrady). Ingestion of small plastics by filter feeders at the base of the food pyramid is known to occur (Moore), but has not been quantified. "There is also potential danger to marine ecosystems from the accumulation of plastic debris on the sea floor . . . The accumulation of such debris can inhibit the gas exchange between the overlying waters and the pore waters of the sediments . . ." (Derraik). The extent of this problem and its effects, have yet to be investigated.

119 CHARACTERIZING AND SURVEYING OCEANIC SOURCES AND SINKS OF MARINE DEBRIS

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As problems caused by the increased presence of anthropogenic marine debris in the North Pacific Ocean continue to manifest across the basin, the focus of studies is steadily evolving from attempts at basic identification of debris hot-spots to strategies for at-sea removal. Having recently completed oceanographic analyses and aerial surveys in the North Pacific subtropical convergence zone, members of the Ghostnet Project Team are now looking at the area of the North Pacific known as the "Eastern Garbage Patch" (EGP). This area can be characterized by sustained high atmospheric pressure resulting in convergent surface flow and low ocean productivity. During August of 2005, we used real-time information from environmental satellites and atmospheric models to guide CAPT Charles Moore and the *SRV Algalita* for a survey of the EGP. The vessel was equipped with four Oceantrek drifters to be deployed on debris masses as part of a larger study to ascertain the movement of such debris with respect to the atmospheric and oceanic forcing. Having successfully brought the ship to the EGP using the NAVY NOGAPS model and satellite-based measurements of sea surface height and chlorophyll a concentration, these drifters were deployed on nets and bundles of debris. The drifters were tracked using on-board global positioning system (GPS) and data telemetry via low-Earth orbit satellites. The observed movements were tested against results from several transport models with the intent of identifying the best model for planning future survey and interdiction activities in the EGP.

120 LONG-TERM TRAJECTORIES OF PLASTIC FLOTSAM IN THE NORTH PACIFIC OCEAN CALCULATED BY THE "OCEAN SURFACE CURRENT SIMULATOR"–OSCURS

W. James Ingraham, Jr. (NOAA Fisheries, retired). DriftBusters Co., 720 Camano View Road, Camano Island, WA 98282

Oceanic drifters can only measure ocean currents for a few years. OSCURS can simulate drift for 35 years by using empirical formulae to compute wind then surface ocean currents daily (0000Z) from a 90km grid of sea level pressure from 1/1/1967 to present. Originally calibrated with satellite-tracked drifters with parachute drogues, OSCURS trajectories have also shown good agreement with World Ocean Circulation Experiment (WOCE) drifter trajectories. New evidence is shown that the North Pacific's cyclonic Subarctic Gyre north of 40 N has a three year orbital period while estimates for the North Pacific's anticyclonic Subtropical Gyre south of 40 N are an orbital period of about 6 years. Within the slow moving center of the Subtropical Gyre is a convergence zone where flotsam of all kinds can have residence times of greater than 20 years, sometimes called the Eastern and Western Garbage Patches. Computer simulations of long-term trajectories show the features of North Pacific Ocean surface currents and the critical areas of bifurcation where flotsam can move between gyres or leave the North Pacific. These areas also change with season and year-to-year climate variations.

121 QUANTITATIVE ANALYSIS OF POPS IN PLASTIC DEBRIS IN THE OCEAN

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The growth in plastic production in the last sixty years has made plastic materials one of the main pollutants of oceanic waters and of beaches. Low production costs, high physical resistance to aging and minimal biological degradation has meant that plastic objects, fragments and residues accumulate and persist. Persistent Organic Pollutants (POPs) are synthetic organic compounds with the following properties: highly toxic; wide range of chronic effects (endocrine disrupters, carcinogenicity, mutagenicity); stable chemically; and, not easily degraded in the environment or in organisms. They are lipophilic and accumulate in the food chain. The objective of this research is to assess plastic fragments and pellets found in the marine environment to determine the concentrations of selected Persistent Organic Pollutants (POPs) including PCBs, PAHs, aliphatic hydrocarbons, and chlorinated organic pesticides. The plastic samples were fragments and pellets with a wide range of sizes and shapes. They were found to be primarily polypropylene and polyethylene, which is consistent with the buoyancy of these polymers. The plastic was identified using a Shimadzu 8300 FT-IR Spectrophotometer. Virgin pellets from different industrial sources were also analyzed to look for target compounds in the pellets not exposed to seawater. The plastic debris samples collected in the North Pacific Gyre, contained PAHs, some PCBs and Pesticides. These compounds were identified and quantified using a JEOL GCmate GC/MS. The mass spectrometer was operated in SIM mode. This finding confirms the hypothesis that plastic debris can accumulate hydrophobic compounds (POPs) from the marine environment.

122 INTERNATIONAL PELLET WATCH: GLOBAL MONITORING OF PERSISTENT ORGANIC POLLUTANTS (POPs) BY USING BEACHED PLASTIC RESIN PELLETS

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Plastic resin pellets are industrial raw material and are unintentionally released to the environment, both during manufacturing and transport. The released resin pellets are carried eventually to the ocean. Because of their environmental persistence, they are distributed widely in the ocean and found on beaches all over the world. Because of the hydrophobic nature of the plastic pellets, hydrophobic organic pollutants such as PCBs, DDTs, and PAHs are enriched in the pellets with concentration factor of $\sim 10^6$. In our preliminary study covering whole Japanese beaches correlation was observed between concentrations of PCBs in beached resin pellets and those in mussels, although concentrations of PCBs in the pellets are largely influenced by residence time and pathways of resin pellets from the sources to the stranding points. Based on the finding, we've proposed "International Pellet Watch (IPW)" project to monitor persistent organic pollutants (POPs) in world ocean. In the project, we call world citizens to collect beached resin pellets on their nearby beaches and send them via airmail to our laboratory where the resin pellets will be analyzed for POPs by using our instruments including FOCUS-Polaris Q GC/MS which is kindly provided by Thermoelectron KK, Japan. Based on the analytical results, global distribution of POPs will be mapped and released on web. The advantage of IPW is extremely low cost for sampling and shipment of the samples and non-scientists participate to the monitoring as a part of environmental education. Details of the project is available on website (http://www.tuat.ac.jp/~gaia/ipw/index.html).

123 SHIPS FOR SCRAP AT ALANG-SOSIYA: LOOMING OF SMALL PLASTICS IN MARINE SEDIMENTS

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Accumulation of plastics and their tidbits in beach, estuarine and sub-tidal sediments pose a big challenge to the environment as they do not degrade easily, drift for years, cover vast areas and persist for a long period of time. These plastic articles eventually, breakdown into smaller fragments, staying in suspension in the water column or settling in the sediments, and therefore inhibiting the vertical transfer of oxygen and percolation of water across it. Additionally, the plastic pellets and fragments not only support the growth of hydroids, diatoms, and bacteria but also transfer chemical pollutants including polychlorinated biphenyls, (PCBs); 1,1-dichloro-2,2-chlorophenylethylene (DDE) and nonyl phenols (NP) to organisms. Attempts have been made earlier to quantify the plastic debris of various marine environments. However, the extent of accumulation and classification of small plastics in marine sediments at ship scrapping yards, where large-scale accumulation is possible besides huge employment and financial benefits, have not been studied as yet. The present paper discusses the extent of accumulation of small-plastics in the intertidal sediments of a world's largest ship-breaking yard at Alang-Sosiya, established in 1982 on the NW of Gulf of Cambay, India. The small plastics and their associates have been collected, separated under microscope and identified by FT-IR spectroscopy as polyurethane, nylon, polystyrene, polyester and glasswool. The morphology of the identified plastics has also been studied by Scanning Electron Microscope. Overall, the small plastics weighed around 81 ± 4 mg per kg of sediment, of which the transparent plastics and nylon together contributed 37%.

124 WHAT THE PLASTIC INDUSTRY MUST DO IF WE ARE TO KEEP PLASTIC OUT OF MARINE DEBRIS AND GET TO ZERO WASTE

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The reuse and recycling/composting of fiber and organic material and the recycling of textiles, ceramics, metal, glass, can be found as an industry in all cultures in the world. The use of plastic for durable goods and packaging is increasingly taking the place of other materials. The result has been an increasing amount of plastic materials being sent to landfill and incinerators that are subsidized by the general public. The Plastic Industry needs to develop a closed loop recovery system and include recovery in the product design. RAA recommends that the industry perform a cradle to cradle analysis of its products and plan for recovery and reuse. The industry must design packages and product for dismantling and recycling and include post consumer content. Products must be tested as a precautionary principal for human impacts before allowed to be distributed. The manufacturing systems must be clean without residual runoff. All plastic types must be labeled or signaled in such a way as they may be recognized for recovery. The industry must create the plastic equivalent of the scrap yard or paper yard to receive clean products from self hauled and private businesses. If the plastic industry creates recovery loops for their products, businesses will be the first to take advantage of the savings, and once established the government programs will follow. As cities across the world endorse zero waste goals, industry could be proactive or they can wait until government makes them do it.

125 LAMPREYS SOUTH OF POINT CONCEPTION AND PERSPECTIVES FROM THE NORTH

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Two species of lamprey are native to California south of Point Conception, the Pacific Lamprey, *Entosphenus tridentatus,* and an unresolved brook lamprey, *Lampetra* cf. *pacifica,* which is apparently extirpated from its known range in southern California. The North American range of the Pacific Lamprey extends from Alaska south to the Río Santo Domingo in northern Baja California, including records from many principal streams in southern California. However, a recent coast-wide survey of streams from Canada south to Baja California suggests that there is a major change in population dynamics south of Point Conception. While Pacific Lamprey ammocoetes (a freshwater-resident larval stage lasting about five years) are nearly ubiquitous from San Luis Obispo northwards, they are extremely rare or absent southwards, even at sites of recent collections and known populations. The mechanisms causing this pattern remain to be resolved, but may include different life-history strategies related to oceanographic and hydrologic environments, natural habitat constraints, or anthropogenic changes in the environment. Historically, there was also a freshwater-resident brook lamprey in the Los Angeles Basin, including the San Gabriel, Santa Ana, and Los Angeles drainages. However, the species has not been collected from its known range in the basin since 1955. One goal of this project is to increase awareness of lampreys in southern California streams and provide information on extant northern brook lampreys that may aid field biologists in their search for possible relict populations of this elusive lamprey.

126 THERMAL ECOLOGY OF STEELHEAD IN A WARM-WATER ENVIRONMENT

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How salmonids adjust to the cost of chronic exposure to warm water in nature, particularly in habitats where areas of cold water are unavailable, is largely unknown. In the hot dry climate of southern California, oversummering juvenile steelhead, *Oncorhynchus mykiss,* can experience an unceasing warm-water environment. A study performed in Topanga Creek, Los Angeles County, during

July and August 2004 assessed how steelhead (10 to 28 cm TL) exploited the thermal environment. Analyses of achievable body temperatures, an index of observed body temperatures, and behavioral time budgets, indicate steelhead did not behaviorally thermoregulate. Juvenile steelhead accepted an elevated body temperature (18.7 to 24.5°C) and remained active and foraged throughout the day at the extreme southern extent of their geographic distribution. The high body temperature that steelhead accept appears to represent a compromise in exchange for an expanded range of thermal habitats.

127 SOUTHERN CALIFORNIA STEELHEAD: WHERE AND WHAT ARE THEY?

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The distribution and character of southern populations of Southern steelhead (*Onchorhynchus mykiss*) has become the focused attention of biologists, resource managers, political decision makers, and the general public since listing as an endangered species under the Endangered Species Act in 1997 (and southern extension in 2002). Increased attention has resulted in new information on distribution and occurrence of both juveniles and sea run-adults, as well as on their physiological characteristics and ecological role. The perceived distinction between the freshwater resident life-history forms and the anadromous life-history forms of *O. mykiss* differs with the perspective of the viewer's vantage point: taxonomists, ecologists/evolutionists, regulators, and resource managers may have different ways of looking at the same fish. The diversity of the habitat conditions occupied *O. mykiss* is mirrored in the diversity of life-history patterns which they exhibit, but the geography of these differences is unclear, as well as the specific mechanisms which account for expression of this diversity. While the run-size of southern California steelhead populations have decline dramatically over the past 100 years, research activities and opportunities on *O. mykiss* in its fresh and marine water habitats have increased. Recovery planning currently underway by NOAA Fisheries will guide and stimulate both research and conservation measures over the next several decades.

128 HABITAT EVALUATION FOR SOUTHERN POPULATIONS OF STEELHEAD TROUT, *ONCORHYNCHUS MYKISS*

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Southern California populations of steelhead trout (*Oncorhynchus mykiss*) live in flashy, warm, sometimes intermittent, highly variable streams. How do we evaluate habitat quality for these unique fish? Many of the protocols and parameters established to evaluate habitat for *Oncorhynchus mykiss* were developed based upon research conducted on steelhead from the Pacific Northwest and Northern California, or on rainbow trout from other parts of the country. Several field surveys to evaluate habitat quality for steelhead have been conducted in recent years in the Santa Ynez,Ventura, and Santa Clara systems, as well as streams along the Conception Coast and the Santa Monica Mountains. Researchers in Southern California modified these existing protocols to more adequately reflect local conditions. Modified parameters include those dealing with habitat type, flow, temperature, instream cover, riparian vegetation, and substrate. At the 2005 Salmonid Restoration Federation meeting, a session on this topic included presentations of the field work described above and a group discussion about how we might modify assessment protocols. Some of the issues discussed include: Do southern steelhead have different temperature and dissolved oxygen tolerances than more northern populations? How does this related to food availability, and nutrient levels? Are spawning substrates used differently? Should instream cover provided by boulders be weighed more heavily? What is the role of large woody debris? What is a "pool" in the context of a southern California stream? Should bank vegetation assessments include a category for invasive plants? This presentation will review the results of that meeting, and examine future directions in the evaluation of habitat for southern populations.

129 SURVIVAL ON THE EDGE: THE PLIGHT OF THE SAN MATEO CREEK SOUTHERN STEELHEAD

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The discovery of a small population (<70 individuals) of southern steelhead trout, *Oncorhynchus mykiss* in San Mateo Creek (SMC) and Devil Canyon Creek (DCC), a small tributary to SMC in San Diego County, California in the spring 1999 represents the first multiple record account of trout in the creek in over 50 years. From August 1999 to April 2006 the California Department of fish and Game (CDFG) has been involved in an extensive monitoring program along both creeks to monitor the status and health of the newly found steelhead population. Data on trout abundance, age analysis, genetics, otolith micro-chemistry, temperature profiles and spawning behavior have been routinely collected. Utilizing the data collected, CDFG biologists were able to construct a conclusive chronological graph of trout presence and of lineage relationships for the trout on SMC and DCC from their discovery in 1999 to the last sighting of trout on the drainage in December 2003. While trout presence in SMC and DCC has not been observed since 2003, Salmonid observations in adjacent streams in 2002, 2003 and 2004 are promising. The ephemeral presence of southern steelhead within San Mateo Creek is to be expected when the population of anadromous adults in the southern portion of their range is considered low. Additionally, a number of events need to align (water availability, creek access and adult steelhead presence) in order for anadromous immigration into the creek to occur.

130 STATUS OF THE THREESPINE STICKLEBACK IN SOUTHERN CALIFORNIA

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The circumboreal threespine stickleback, *Gasterosteus aculeatus,* once inhabited all the major, and many minor, drainages in Southern California. Development and water harvest has restricted their current distribution, eliminating some populations and threatening or restricting the distribution of others. Southern California has populations of three forms of stickleback: the widespread low-plated form of *Gasterosteus aculeatus,* including those found in San Antonia Creek; an unplated form endemic(?) to the Santa Clara River in Los Angeles County, *G. a. williamsoni,* which is listed as federally endangered; and a possible undescribed species, the Shay Creek stickleback, endemic to the endorheic Baldwin basin. Introductions of *G. a. williamsoni* have been tried in Malibu Creek and in San Felipe Creek. The Shay Creek stickleback has been introduced into artificial ponds, Sugarloaf Meadow and Juniper Springs, in the San Bernardino Mountains. Low-plated populations in San Jacinto Creek, Strawberry Creek, Mohave River and Holcomb Creek are believed to be trout related introductions.

131 UPDATE ON *RANA MUSCOSA* IN SOUTHERN CALIFORNIA

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The mountain yellow-legged frog (*Rana muscosa*) has suffered precipitous declines over the past 35 years in southern California. The remaining populations are unstable and continue to be impacted by disease, fires, floods, debris flows, and invasive species. We will review the status of this species based on our field data from 2000–2005 and make some recommendations about future prospects of these populations. Adaptive management is immediately needed at most populations if they are to stabilize and increase. Additionally, extirpated populations need to be re-established if these species are going to persist in the region.

132 AN UPDATE: ECOLOGY, STATUS, AND CONSERVATION OF THE WESTERN SPADEFOOT TOAD, *SPEA HAMMONDII*

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The western spadefoot toad, *Spea hammondii,* is a fossorial amphibian with secretive habits. Observations of adults are infrequent and highly correlated with periods of rainfall while observations of eggs, larvae, and metamorphic individuals are limited to a period of weeks and only in those years that breeding occurs. Given its secretive habits and limited opportunities to detect, this amphibian can be difficult to study. However, based the observational data I have collected over the last ten years, I will discuss several important issues that typically have *not* been associated with the western spadefoot.

This species is often characterized as requiring ephemeral pools located in the upland for breeding. I will describe the importance of zero and first order headwater drainages as breeding habitat for populations occupying landscapes lacking relatively flat valley bottoms or mesa tops. In addition, I will discuss the relationship between ecological and life history aspects of the toad as it relates to landscape changes and how that interaction has changed the geographic and local distribution of the western spadefoot. Finally, despite its precipitous decline, I will discuss why this species should not be considered for listing as a federal threatened or endangered species at this time.

133 STATUS OF THE CALIFORNIA RED-LEGGED FROG (*RANA DRAYTONII*) IN SOUTHERN CALIFORNIA

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According to the fine map compiled by Jennings and Hayes (1994), the California red-legged frog once occurred at more than 100 localities in southern California, from Santa Barbara, Ventura, Los Angeles, and San Bernardino counties southward. Now, approximately 75% of these populations is extinct. Urbanization has clearly been the most important cause of the extinctions, although introductions of exotic, predaceous fishes and other factors contributed in some areas.

Throughout the state, the California red-legged frog extinction pattern has been characterized by a gradual severing of metapopulation ties, and the disappearance of isolated peripheral populations, leaving several scattered core areas. In southern California, the only core persists in the mountains of Ventura and Santa Barbara counties, and along the Santa Barbara coast. An isolated population still exists in San Francisquito Canyon, Los Angeles County, but other isolates in Los Angeles and Riverside County have recently gone extinct, and further extinctions are predicted.

134 CONSERVATION IMPLICATIONS OF INTRODUCED AMPHIBIAN SPECIES IN SOUTHERN CALIFORNIA: INSATIABLE PREDATORS OR PLENTIFUL PREY

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The introduced bullfrog (*Rana catesbeiana*) and African-clawed frog (*Xenopus laevis*) are now permanent and ubiquitous components of our freshwater habitats in coastal southern California. These invasive and predatory species are known to compete with and prey on native fauna, including some sensitive and at-risk species. However, few studies in our region have been designed to quantify the effects these introduced species have on native species at the population level. A major challenge in demonstrating the direct and indirect effects of these introduced species is that, where they occur, other modifications to the habitat have also occurred (hydroperiod, geomorphology, community composition, vegetation structure, etc.). Consequently, it is difficult to single out specifically what effects these introduced amphibians have on native fauna (positive or negative) due to the confounding aspect of the multitude of other physical and biological habitat modifications.

Specific to the conservation of native amphibian species, it is critical to understand the effects these introduced amphibians have on the habitat quality prior to the development of reintroduction plans for species such as the endangered California Red-legged Frog (*Rana draytonii*). I will discuss the bullfrog and the African-clawed frog in the context of a food web, and discuss how the modified wetlands occupied by these introduced amphibians would not serve as suitable locations for future reintroductions of the California Red-legged Frog. I will conclude discussing the rational for why the presence of the bullfrog can be considered an 'ecological synecdoche' and what its presence indicates in terms of overall habitat quality.

135 A PLACE-SPECIFIC EDUCATION PROGRAM TO INCREASE AWARENESS OF INTRODUCED STREAM PREDATORS AND THEIR ROLE IN NATIVE AMPHIBIAN DECLINE

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In the Santa Monica Mountains near Los Angeles, CA, USA, stream breeding amphibian populations (namely the California treefrog *Hyla cadaverina* and the California newt *Taricha torosa*) have been in decline largely due to the introduced red swamp crayfish (*Procambarus clarkia*). Recent efforts to remove crayfish in a Malibu stream led to a marked increase in California newt reproduction, suggesting that management to reduce introduced predators can be an effective method of conserving threatened amphibian species. Of particular interest to area conservation agencies is the prospect of community-based management of invasive species. A public that is educated on the threats posed by invasive species is important for community-based management to be a possibility. We have produced an education program to be used in local schools and at public gatherings which combine age-appropriate PowerPoint® presentations with supplemental information sheets, school activities and evaluation instruments. The program emphasizes the dependence of native amphibians on mountain stream habitats and the disruption caused by introduced predators. The program has been presented in eleven classrooms and ten civic events by students from Pepperdine University. Before and after evaluations (N = 150 for schools and N = 70 for adults at civic events) indicate a 40% increase in the ability of students to recognize species and to discriminate natives and non-natives as a result of participating in the program. Adults show an improvement of 20% in similar evaluations. Such locally adapted educational programs can be instrumental in laying the ground work for community-based conservation efforts.

136 GROWTH AND DEMOGRAPHY OF WESTERN POND TURTLES AT VANDENBERG AIR FORCE BASE, CALIFORNIA

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Western pond turtles (*Emys marmorata*) occur throughout much of California. Vanbenberg AFB is along the coast in southern San Luis Obispo County, and has a Mediterranean climate with wet winters and dry summers and year-round moderate (10–25° C) air temperatures. This is in contrast to inland sites in California where temperatures often drop to freezing in winter and exceed 35° C during summer. In April 1995 and June 1996 we trapped pond turtles at five natural and man-made ponds on the air force base and took mass, several shell measurements, sex, age, and growth histories. Combining all ponds, we captured 174 turtles; 66% were males, 15.5% females, and 18.5% juveniles. Turtles $\geq$ 120 mm carapace length (CL) accounted for 83% of turtles caught, although 49% of turtles were 5 years old or less. The average CL of the upper 10% of male and females were not significantly different (Male CL = 162.1 mm; Female CL = 160.7 mm). Turtles grew quickly and reached 120 mm CL by about 4 yr, although males reached 150 mm CL by 8 years but females were 11 years when CL was 150 mm. Female turtles were x-rayed in June 1996 and 68.4% were gravid. Mean clutch size was 5.2 eggs and ranged from 3–7 eggs. Despite the skewed sex ratio (4.3 M/1 F), many young turtles were found at the base and growth rates of both sexes were almost as high as turtles living in the warmer Central Valley of California

137 THE GARTER SNAKES OF SOUTHERN CALIFORNIA

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Despite the relatively arid climate, six species of garter snakes occur in southern California, defined here as that area south of the northern borders of San Luis Obispo, Kern and San Bernardino Counties. While all tend to be associated with riparian habitats, the degree to which they depend on permanent water varies. Two of the six species (Aquatic GS and Western Terrestrial GS) occur along the immediate coast inland to the Coast Ranges and south into Santa Barbara and Ventura Counties, respectively. An isolated population of the latter also occurs in the San Bernardino Mountains. The Common GS is confined to the immediate coast and adjacent drainages, ranging south into San Diego County. Populations south of Santa Barbara County are disjunct, probably endangered and possibly represent a new subspecies. The Sierra GS appears to have small, disjunct populations ranging from the southern Sierra Nevada through the Tehachapi Mountains to the vicinity of Frazier Park in Kern County. There, its range abuts that of the Two-striped GS. The Two-striped GS is the most wide-ranging of the southern California garter snakes, occurring from San Luis Obispo County south to the Mexican border and inland through the inner Coast, Transverse and Peninsular Ranges. One of the more highly aquatic species, urbanization has taken much of its lowland habitat and it is officially recognized as a state

Species of Special Concern. The Checkered GS occurs along the Colorado River and adjacent irrigation canals in Imperial and Riverside Counties where its current status is unknown.

138 GENETIC STRUCTURE IN SOUTHERN CALIFORNIA COASTAL STREAM VERTEBRATES: SANTA ANA SPECKLED DACE, THREESPINE STICKLEBACK, AND CALIFORNIA TREE FROG

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We have evaluated genetic variation and population structure in both fish and amphibian taxa in the freshwater streams of southern California using mitochondrial cytochrome b sequence data. Patterns of genetic variation in the unarmored three spine stickleback (*Gasterosteus aculeatus* spp.) and the California tree frog (*Pseudacris cadaverina*) indicate that both historical processes over a wide range of time and space, and extant biogeographic variables shape the current geographic population structure. Such influencing factors are inferred, but rarely witnessed. We now have an opportunity to examine the combined effects of fire and flood on population structure in Santa Ana speckled dace (*Rhinichthys osculus* ssp.). We sampled dace in five tributaries to the inland reach of the Santa Ana River in San Bernardino county immediately prior to the fire and flood regime of 2003–2004. The combine effects of these events resulted in severe impacts to these streams from debris flow and the extirpation of dace in two of the five streams. We are currently obtaining genetic data on the pre-cataclysmic populations, and plan to sample post-cataclysmic populations to estimate the impacts on genetic structure.

139 USE OF ULTRASOUND TO RISH-STRATIFY PREGNANCY OUTCOME IN EMERGENCY DEPARTMENT PATIENTS WITH FIRST TRIMESTER VAGINAL BLEEDING

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Vaginal bleeding during the first trimester of pregnancy can be a result of spontaneous abortion, gestational trophoplastic disease, implantation bleeding, cervical ectropion, cervicitis and ectopic pregnancy, which must not be misdiagnosed. It is essential to include all diagnoses due to potential life threat and threatened abortion. Pelvic ultrasonography will be the best procedure to evaluate every pregnant patient with vaginal bleeding in early pregnancy due to no evidence of risk to mother or fetus, and immediate test results while providing five potential diagnoses in such situations. For example, pelvic ultraonography can reveal *NDIUP* (no definitive intrauterine pregnancy), *IUP* (intrauterine pregnancy), *Live IUP* (live intrauterine pregnancy), *Abnormal IUP* (abnormal intrauterine pregnancy), and ectopic pregnancy. Finding *NDIUP, IUP* and *Live IUP* indicates potentially viable pregnancies. Finding *Abnormal IUP* and ectopic pregnancy displays non-viable pregnancies. If transabdominal technique fails to distinguish a gestational sac, a yolk sac and live intrauterine pregnancy, endovaginal technique will be performed under standards of care in order to obtain better images. The ultrasound performed provides very unusual information of a uterus such as a gestational sac, a yolk sac, fetal heart motion, and fetal pole. The goal of this research is to evaluate if and how finding *NDIUP, IUP,* and live *IUP* may result in a better and faster prediction of live birth from vaginal bleeding during the first trimester of pregnancy. We expect to dramatically accelerate a doctor's ability to diagnose a patient who is suffering from vaginal bleeding during the first trimester of her pregnancy with pelvic ultrasonography.

141 HAS THE STATE BAN ON AQUARIUM *CAULERPA* SPECIES BEEN EFFECTIVE IN SOUTHERN CALIFORNIA?

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The *Caulerpa taxifolia* invasion of the Mediterranean Sea raised awareness of the potential for introduced seaweeds to impact coastal communities. Subsequent introductions of *C. taxifolia* in southern California in 2000, presumably from the release of aquarium specimens, led to the expenditure of

more than $4.5 million for eradication efforts. Besides *C. taxifolia,* other species of *Caulerpa* being sold for aquarium use also may have the potential to invade southern Californian and U.S. waters. To determine the availability of aquarium specimens of *Caulerpa* in southern California, 50 retail outlets were visited in 2000–01 and 52% were found to sell *Caulerpa*;10% of these stores sold *C. taxifolia.* Surveys of aquarium stores in Florida produced similar results and also revealed the ability to purchase *Caulerpa* via e-commerce. In late 2001, California imposed a ban on importation, sale, or possession of 9 *Caulerpa* species; the City of San Diego expanded these regulations to include all species. To determine the effectiveness of the California ban on *Caulerpa,* in 2005–06 we visited 24 retail stores previously found to sell *Caulerpa.* Of 24 stores, 63% sold *Caulerpa* and 8% were selling *C. taxifolia.* These results together with recent work in Florida suggest that the retail aquarium industry, including e-commerce, continues to represent a potential vector for distributing *Caulerpa* specimens, including *C. taxifolia.* It also appears that outreach and enforcement programs in the City of San Diego have resulted in greater compliance with existing regulations underscoring the need to increase awareness among the aquarium retail industry.

142 MUSCULATURE OF THE MODIFIED RIB FOUND IN CYPRINIFORM FISHES

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The Weberian apparatus is a series of bones that interconnect the gas bladder with the inner ear of some fishes. Within the literature there are descriptions of the hard elements of the apparatus including the highly modified ribs but the soft elements like the extrinsic muscles have received little attention. The modified rib of the fourth vertebra (V4) and its musculature are the basis of this study. Twenty one species from five cypriniform families, Cyprinidae, Catostomidae, Cobitidae, Psilorhynchidae, and Gyrinocheilidae, and several out-group representatives of Characiformes and Siluriformes, were dissected to describe and attempt to understand the function of the musculature attaching to the gas bladder and the V4 rib. In the cypriniform species examined, a muscle, the cleithropleuralis, interconnects the medial cleithrum with the ventral tip of the V4 rib. The swimbladder protractor interconnects the ventral surfaces of the first three vertebrae with the cranial surface of the gas bladder. The cleithropleuralis is similar in cyprinids and catostomids but the swim bladder protractor was more robust in cyprinids. In silurids, the swim bladder protractor is a broad muscle covering the anterior end of the gas bladder and extending to the ventral surface. In cypriniforms it is a centralized muscle attaching to only the anterior face of the gas bladder. Based on the position of the cleithropleuralis, I pose that it could be used to fine-tune the tension in the gas bladder external covering for improved sound reception or possibly to provide a means of directional location of sounds.

143 STRESS AND CONSEQUENCES IN THE URBAN OCEAN–ENVIRONMENTAL ENDOCRINOLOGY OF MARINE FISHES OF THE SOUTHERN CALIFORNIA BIGHT

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The urban ocean environment presents a variety of stressors to marine wildlife, from disturbances such as direct contact with humans (e.g., catch & release) to environmental contamination (e.g., from stormwater or sanitation district outfalls). As in all vertebrates, fishes respond to environmental stressors via a highly integrated neuroendocrine system (hypothalamo-pituitary-interrenal (HPI) axis) that results in production of the steroid, cortisol. Depending on the nature of the stressor(s) presented to a fish, and the species under consideration, plasma cortisol levels may increase >200-fold (e.g., with capture and captivity) and remain elevated if the stressor(s) persists. Secondary physiological impacts of the cortisol response include impairment of the HPI axis itself, disruption of the growth endocrine system, and inhibited defense mechanisms, particularly under situations of chronic stress. The regulation and observed dysregulation of stress responses in urban ocean fish will be discussed in terms of underlying steroidogenic mechanisms and potential impacts on other physiological systems. [Support in part by Southern California Sea Grant & California Sea Grant College Programs.]

144 EVALUATION OF RELATIONSHIPS BETWEEN REPRODUCTIVE METRICS, GENDER AND VITELLOGENIN EXPRESSION IN DEMERSAL FLATFISH COLLECTED NEAR THE MUNICIPAL WASTEWATER OUTFALL OF ORANGE COUNTY, CALIFORNIA, USA

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Estrogenic activity in fish has primarily been evaluated using vitellogenin (vtg) expression in male and juvenile animals. Although the response has been widespread in field and laboratory studies, the relevance of the response to higher-level adverse effects, particularly in the field, is less than clear. Previous evaluations of vtg within flatfish species collected near the Orange County Sanitation District (OCSD) outfall and stations as far as 7.7 km down current indicated bioavailable estrogens within demersal flatfish populations. In order to evaluate the persistence of estrogenic activity and relationships to reproduction and development, fish were sampled in the winter and summer of 2003 and 2004 from the same locations and vtg, plasma estradiol (E2) concentrations, gonadosomatic indices (GSI), sperm DNA damage, development and gender ratios were measured in English Sole (*Pleuronectes vetulus*) and Hornyhead Turbot (*Pleuronichthys verticalis*). Variable levels of vtg were continually observed in plasma samples from fish collected in the locations analyzed. Vtg expression and plasma E2 levels were significantly correlated in females of both species. A positive relationship was demonstrated between plasma E2 levels and sperm DNA damage. Rather than an expected feminization of populations, a trend toward masculinization was observed particularly at the OCSD outfall, as indicated by gender ratios and significantly higher GSI in males versus males from the reference station. These results are consistent with previous studies showing vtg expression in male flatfish, but no alteration in overall flatfish abundance at the sampled sites.

145 SEASONAL EVALUATION OF REPRODUCTIVE STATUS AND EXPOSURE TO ENVIRONMENTAL ESTROGENS IN HORNYHEAD TURBOT AT THE MUNICIPAL WASTEWATER OUTFALL OF ORANGE COUNTY

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In the sediments near the outfall of Orange County Sanitation District (OCSD), detectable levels of 17β-estradiol, alkylphenol ethoxylates and alkylphenols, raise concerns about the heath of biota. Hornyhead turbot (*Pleuronichthys verticalis*), a flatfish dwelling in the sediment and feeding on benthos, may experience significant exposure via water, sediment and prey to environmental estrogens. As part of a multi-year monitoring project, fish collected in February, August and November 2005 at the outfall (T1) and a farfield site (T11) 7.7 km north of the outfall were analyzed for condition factor (CF), gonadosomatic index (GSI), plasma vitellogenin (Vtg) concentrations, and histopathology of gonads (August and November samples only). The above endpoints were evaluated to determine whether reproductive status changed seasonally and to identify the suitability of T11 as a reference site. The results indicated that site differences were not statistically detected for CF, GSI, developmental status, and Vtg concentrations of females but seasonal changes were well pronounced in most of the cases. Incidences of ovarian atresia were observed in 4 of 5 females collected at T11 in August but no incidence of ova-testis was observed. Vtg concentrations in males were significantly different between the two sites with higher values in T11 in February and August but lower values in November. With the exception of male samples collected at T11 in November, the average male Vtg concentrations of all the sampling events exceeded the concentrations of purged control animals and male animals collected at Dana Point in February 2006. Over all, the results exhibited estrogenic responses and similar developmental status in male hornyhead turbot at T1 and T11. With undetectable Vtg concentrations similar to purged control animals, males collected at Dana Point in February suggest that this location has potential as a reference site for further evaluation.

146 REGION-ASSOCIATED DISRUPTION OF FLATFISH ENDOCRINE SYSTEMS–STUDIES IN THE SOUTHERN CALIFORNIA BIGHT

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Despite the enormous human population affecting southern California's marine environment, the issue of environmental endocrine disruption in marine wildlife has been poorly studied in this region. Our work and that of our collaborators has uncovered evidence of endocrine-disrupted states in flatfish living in locales affected by wastewater treatment plant (WWTP) outfalls, as compared with fish at more distal "reference" sites. Among these pieces of evidence are a blunted endocrine stress response (impaired hypothalamo-pituitary-interrenal axis) and significantly reduced levels of the important growth-regulatory peptide, insulin-like growth factor-I (IGF-I). Additionally, in a non-migratory flatfish species (hornyhead turbot, *Pleuronichthyes verticalis*), levels of the sex steroids, 17β-estradiol and testosterone are significantly altered in association with proximity to WWTP outfalls. These observed endocrine alterations will be discussed in terms of potential underlying causes and interactions between endocrine systems in these fishes. [Support by Southern California Sea Grant College Program.]

147 *IN VIVO* BIOASSAY GUIDED FRACTIONATION OF MARINE SEDIMENT EXTRACTS FROM THE SOUTHERN CALIFORNIA BIGHT FOR ESTROGENIC ACTIVITY

D. Schlenk[1]*, Y. Sapozhnikova[1], M. Irwin[1], L. Xie[1], W. Hwang[1], S. Reddy[2], B.J. Brownawell[2], J. Armstrong[3], M. Kelly[4], D. E. Montagne[5], E.P. Kolodziej[6], D. Sedlak[6], S. Snyder[7]. [1]Department of Environmental Sciences, University of California, Riverside, CA, USA; [2]Marine Sciences Research Center, Stony Brook University, Stony Brook, New York, USA; [3]Ocean Monitoring, Orange County Sanitation District, Fountain Valley, CA USA; [4]Ocean Monitoring, City of San Diego, San Diego, CA, USA; [5]Ocean Monitoring & Research Group, Los Angeles County Sanitation Districts, Whittier, CA, USA; [6]Department of Civil and Environmental Engineering, University of California, Berkeley; [7]Water Quality Research and Development Division, Southern Nevada Water Authority, Las Vegas, Nevada

The exposure and uptake of environmental estrogenic compounds have been reported in previous studies of demersal flatfish species in the central Southern California Bight (SCB). The objective of this study was to evaluate the feminizing activity of marine sediments from the SCB by using *in vivo* vitellogenin (Vtg) assays in male or juvenile fish. In 2003, sediments were collected near wastewater outfalls serving the counties of Los Angeles (LACSD) and Orange (OCSD), and the city of San Diego (SD). Cultured male California Halibut (CH) (*Paralichthys californicus*) were either directly exposed to sediments for 7 days or treated with two intraperitoneal injections of sediment extract over seven days. 17β-Estradiol (E2) equivalent values ranged from 1–90μg/kg with LACSD $>$ SD $>$ OCSD. Measurable concentrations of E2 were observed in all sediment extracts. Estrone (E1) was only observed in sediments near the LACSD outfall. Alkylphenols and alkylphenol ethoxylates were observed in all sediment samples but were highest near the OCSD outfall. Fractionation studies of the LACSD sediment extract failed to demonstrate relationships between Vtg expression and 62 analytes including E2, which was observed in whole extract (2.9 ng/g). Oxybenzone (1.6 ng/g) was identified in bioactive fractions as well as unknown compounds of relatively high polarity. These results indicate estrogenic compounds other than classic natural and xenoestrogens may contribute to estrogenic activity of sediments from the SCB.

148 PALOS VERDES SHELF REMEDIATION AND RESTORATION PLENARY–HISTORICAL AND LEGAL OVERVIEW

John Saurenman, Supervising Deputy Attorney General, California Department of Justice

A discussion of the history of DDT/PCB contamination on the shelf, the legal battles which were settled for 140 M dollars, and how that money was divided among the various remediation/restoration entities.

149 PALOS VERDES SHELF REMEDIATION AND RESTORATION PLENARY–INSTITUTIONAL CONTROLS

Sharon Lin, Remedial Project Manager, Public Outreach and Education, USEPA Region 9

The institutional control (IC) program is focused on the protection of human populations at risk to DDT and PCB exposure from eating contaminated fish. The ICs program consists of public outreach to at risk populations, fish contamination monitoring, and white croaker commercial catch ban and bag limit enforcement. The ICs program has bee in full implementation phase since 2002. The stakeholders of the PV Shelf project completed a series of workshops to develop a revised strategic plan for the ICs components in Fall 2005. The presenter will show a video describing the ICs program with an emphasis on the public outreach component of the program, the Fish Contamination Education Collaborative. The presenter will give a status update on the program and discuss any related subjects that are of interest to the meeting attendees.

150 PALOS VERDES SHELF REMEDIATION AND RESTORATION PLENARY–RESOURCE RESTORATION

Dave Witting, Montrose Settlement Restoration Program

Provide an overview of the recently released final plan for restoring natural resource injuries caused by DDTs and PCBs discharged onto the Palos Verdes shelf. The plan details how they intend to restore fishing services, fish habitat, bald eagles, peregrine falcons, and seabirds to the Southern California Bight. The presentation will describe the status of a comprehensive fish contamination study for DDTs, PCBs and mercury and how results from this study will guide resource restoration projects.

151 PALOS VERDES SHELF REMEDIATION AND RESTORATION PLENARY–SITE REMEDIATION

Carmen White, Remedial Project Manager, Superfund Division, USEPA Region 9

Provide an overview of the studies conducted regarding characterization of the site and a discussion of the options being considered for site remediation. EPA is getting ready to release its remedial investigation report, which will show why there are no easy answers to cleaning up Palos Verdes Shelf. Discussion of remedial options is encouraged.

152 NITROGEN DEPOSITION IN SOUTHERN CALIFORNIA: IMPACTS ON PLANT AND FOREST HEALTH, NUTRIENT CYCLING, WATER QUALITY, AND ECOSYSTEM SUSTAINABILITY

Fenn, M.E.* USDA Forest Service, Pacific Southwest Experiment Station, Riverside, CA

Atmospheric nitrogen (N) deposition to montane sites in the South Coast (Los Angeles) Air Basin is the highest reported in North America. Although NOx emissions have declined dramatically in recent years, N deposition yet remains unusually high in montane areas directly exposed to incoming smog. Dry deposition is often the major input form because of long smoggy dry periods. However, in sites with regular fog occurrence, N deposition in fog is also a major N deposition input to forests. Nitrogenous emissions generally come from urban sources comprised of the transportation sector as well as industrial and domestic emissions. In some areas agricultural emissions are still an important but declining source as agricultural land is converted to suburban uses. Nitrogen oxide emissions are precursors to ozone formation; thus N deposition and ozone exposure co-occur in polluted areas. Ozone is phytotoxic while N is generally a plant growth promoter. The combined effects of these pollutant types on forests causes fundamental perturbations in nutrient cycling, tree physiology, fuel accumulation and forest sustainability. The other major environmental impact of chronic N deposition is increased nitrate levels in runoff and groundwater from montane watersheds, decreasing water quality. Accumulated N from atmospheric deposition is affecting low elevation coastal sage scrub ecosystems, chaparral catchments, forest health, and Class I Wilderness areas in southern California.

153 DRY AND WET ATMOSPHERIC DEPOSITIONS OF SELECTED INSECTICIDES IN THE SAN DIEGO CREEK-NEWPORT BAY WATERSHED

Jay Gan,* Wenjian Lao, Svetlana Bondarenko, and Fredrick Ernst. Department of Environmental Science, University of California, Riverside

A Total Maximum Daily Load (TMDL) for diazinon and chlorpyrifos in the Newport Bay watershed was promulgated by USEPA in June 2002 and adopted by the Regional Board in April 2003. Similarly, a TMDL for organochlorine compounds including DDT was promulgated by USEPA and is scheduled for adoption by the Regional Board in 2007. The TMDL implementation plan requires that a study be performed to characterize the significance of atmospheric deposition of selected insecticides in the Upper Newport Bay. In this study we measured levels of selected pesticides, including chlorpyrifos, diazinon, malathion, carbaryl, organochlorine pesticides, and synthetic pyrethroids in the near-surface atmosphere, in dust, and in precipitation at locations in the Newport Bay watershed. Air samples were taken using a high volume sampler with polyurethane foam plugs at four locations in the summer months of 2005. Dust samples were collected using a flat panel at three locations under dry weather conditions. Rain samples were collected through the winter of 2005 and 2006 at three locations in the watershed. Samples were extracted and analyzed using standard methods. Preliminary results in concentrations will be presented and discussed at the meeting.

154 THE DRY DEPOSITION AND RESUSPENSION OF PARTICLE-ASSOCIATED TRACE METALS NEAR A FREEWAY IN LOS ANGELES

Lisa D. Sabin* and Kenneth C. Schiff, Southern California Coastal Water Research Project, Westminster, CA. Jeong Hee Lim, Maria Teresa Venezia, Arthur M. Winer, and Keith D. Stolzenbach, University of California, Los Angeles, CA

Dry atmospheric deposition represents a potentially large source of trace metal contamination in urban stormwater runoff, yet there is a limited amount of research on the relationship between atmospheric emissions and water quality problems in urban areas. In Los Angeles, which has among the worst air quality in the nation, significant quantities of toxic materials are released into the atmosphere every day, and paved road dust represents the largest source of particle-associated trace metal emissions to the atmosphere. In order to better understand the role of roadways as a source of localized trace metal deposition, we characterized the horizontal dry deposition patterns of chromium, copper, lead, nickel and zinc upwind and at increasing distances downwind of the I-405 Freeway in coastal Los Angeles. Dry deposition fluxes and atmospheric concentrations of these metals were highest at the site closest to the freeway, and reduced to approximately urban background concentrations within 150 m downwind of the freeway. Compared with urban background, atmospheric particle size distributions indicated the freeway was a significant source of trace metals on large particles > 6 μm in diameter, which deposit close to their source and account for the increased dry deposition flux rates observed near the freeway. The spatial pattern of measured deposition flux was well predicted by a relatively simple line-source Gaussian plume model modified to include particle deposition and resuspension. The model results indicated dilution by vertical dispersion of the plume was the most important mechanism regulating downwind concentrations and deposition.

155 DEPOSITION AND RESUSPENSION PROCESSES ON SURFACE CONTAMINATION AND AIR CONCENTRATION PROFILES

Jeong Hee Lim*, Keith D. Stolzenbach. Civil and Environmental Engineering Department, University of California, Los Angeles, CA

A formulated line-source Gaussian plume model was used to estimate vertical and horizontal air concentration profiles and horizontal fluxes of surface contamination. The model included both deposition and resuspension parameters. A rapid reduction of air concentration was observed below a height of 5 m and within a 200 m horizontal distance from the source. The ground level concentration was highest when there was no deposition and resuspension, but rapidly decreased with horizontal distance from the source. As deposition velocity increased, the time for surface contamination to reach steady state increased proportionally. The net accumulation of surface contamination increased as the dependence of the resuspension rate on wind speed decreased.

156 USE OF *IN SITU* HATCHBOX STUDIES TO EVALUATE WATER QUALITY EFFECTS

Howard Bailey[1]*, Ben Chalmers[2], and James Elphick[1]. [1]Nautilus Environmental, San Diego, CA; [2]Myra Falls Mine, Campbell River, British Columbia

Laboratory toxicity tests have been criticized on the basis that their results may not reflect site-specific conditions. Conversely, interpreting the results of bioassessment studies may be problematic due to the inability to control for the movements of organisms in the receiving environment, as well as difficulties distinguishing between water quality and habitat effects. Thus, the use of *in situ* studies may provide an opportunity to quantitatively evaluate the potential effects of a discharge under the conditions found in the actual receiving environment. This presentation describes the approach used at the Myra Falls mine to evaluate the potential for discharge effects in the receiving environment. Eyed trout embryos were placed in hatchboxes at different locations to identify any potential for toxicity in Myra Creek. The reference site was located upstream of the discharge, and potential impact sites were located downstream of the discharge. Hatchboxes were also placed at selected locations to identify possible inputs of contaminated subsurface flows. Both lethal and sub-lethal endpoints were evaluated, including survival, hatching success, and growth. Last year's presentation focused on methods and perceived benefits associated with this approach; this year's presentation will focus on some of the practical issues and the results.

157 EVALUATION OF IMPACTS AND BENEFITS ASSOCIATED WITH DISCHARGE OF TREATED EFFLUENT TO THE SANTA CLARA RIVER ESTUARY

Bailey, Howard C.[1]; Stransky, Chris[1]; Kamman, Greg[2]; and Pfeifer, Dan[3]. [1]Nautilus Environmental, San Diego, CA; [2]Kamman Hydrology and Engineering, Inc., San Rafael, CA; [3]City of San Buenaventura, Ventura, CA

The objective of this study was to evaluate impacts and benefits associated with discharge of treated wastewater to the Santa Clara River Estuary. The estuary is located in a semi-arid region of California that has been subjected to intensive habitat and water development over time. The analysis included evaluation of effluent toxicity and sediment quality, as well as investigations of ecological and hydrological function. The frequency and magnitude of toxicity in samples from the estuary was minimal, and not related to the discharge. In addition, the sediment quality investigation indicated that contaminants of concern were not accumulating in estuary sediments, and that the intermittent adverse effects observed in sediment toxicity tests were largely due to grain size effects. The ecological investigation showed that changes in flora and fauna could be attributed to changes in land use that resulted in a decrease in estuary size of approximately 90% between the late 1800s and 2003. The hydrological analysis demonstrated that the discharge accounts for a portion of the river flows that would have historically reached the estuary, but which have been diverted for other uses upstream. Overall, the study demonstrated that the discharge has no demonstrable negative impacts on the estuary, and supports beneficial uses by maintaining water quality and habitat. In a broader perspective, this study is an example of a robust approach that integrates several environmental disciplines to evaluate the extent of impacts (both positive and negative) to a given receiving environment.

158 CHARACTERIZATION OF CHOLINESTERASES FROM TWO DEMERSAL FLATFISH COLLECTED NEAR A MUNICIPAL WASTEWATER OUTFALL IN SOUTHERN CALIFORNIA

Gabriela Rodriguez-Fuentes[1]*, Daniel Schlenk[1] and Jeff Armstrong[2]. [1]University of California Riverside, Riverside CA; [2]OCSD, Fountain Valley, CA

Two cholinesterases (ChE) present in vertebrates, acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) are distributed in tissues in species-specific patterns. English sole and Horneyhead turbot muscle ChE activities were measured from in two locations off the coast of Southern California. Biochemical characterization in both species was done according to differences in size or gender. To characterize the ChEs two substrates were tested: acetylthiocholine iodide (ASChI) and butyrylthiocholine iodide (BSChI). Eserine, BW284c51, and iso-OMPA were used as selective inhibitors for ChE, acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE), respectively. Pesticide sensitivity was evaluated with Aldicarb and Paraoxon.

English sole muscle ChE correlated with total fish length ($r = -0.3271$). No significant differences

were observed between genders and sampling sites. Substrate preference assay shown that both ChE are found in muscle, BChE represents about 36% of the total ChE activity. Data resulting from the use of selective inhibitors suggested the presence of an atypical BChE because its kinetic parameters had characteristics of both ChEs. Higher sensitivity to pesticide inhibition was observed in ChEs from smaller size fish.

Horneyhead turbot muscle ChE activities presented significant differences between males and females but no correlation was found with total length. No significant differences were observed between sampling sites. Both ChEs were also present with BChE activity constituting 88% of the total ChE activity. Selective inhibitor results indicated the presence of an atypical ChE. Male ChE were more sensitive to pesticide inhibition.

Species, size and gender dependent differences in ChE may contribute to differences in susceptibility to ChE-inhibiting toxicants encountered in the environment.

159 TOXICITY IDENTIFICATION EVALUATION (TIE) CASE STUDY OF A GEOTHERMAL ELECTRIC PLANT LOCATED IN SOUTHERN CALIFORNIA

John Rudolph, Chris Stransky, and Howard Bailey. Nautilus Environmental, San Diego, CA 92121

A geothermal electric plant located in Southern California has consistently exhibited toxicity in their monthly NPDES monitoring to the Cladoceran *Ceriodaphnia dubia,* whereas the fathead minnow, *Pimephales promelas,* has not generally shown toxicity. Upon performing acute testing with *C. dubia,* it was determined that samples collected within days of each other were extremely variable in their toxicity. Routine Phase I TIE treatments were generally ineffective at removing toxicity; however, it was determined that the toxicity of the samples was inversely related to pH. In addition, the presence of ammonia complicated interpretation of the TIE results because there was sufficient ammonia present in at least some of the samples to result in toxicity if the pH was increased to 9. TIE testing on several samples collected during a site visit to the plant demonstrated that sulfides and ammonia could be major contributors to the toxicity. However, further investigations into plant operations revealed that frequent chlorination events could be oxidizing ammonia to nitrite. Nitrite analysis of all archived samples indicated that, with few exceptions, a tight relationship existed between nitrite levels and toxicity. Phase II TIE investigations have identified nitrite as the primary toxicant of concern, with ammonia being a secondary toxicant (depending on the pH of the sample). Elevated TDS remains an issue with respect to chronic toxicity to *C. dubia,* and hydrogen sulfide could become a concern depending on seasonal changes in influent streams. Routine monthly testing is continuing in order to confirm these relationships.

160 EXTENT AND MAGNITUDE OF COPPER CONTAMINATION IN MARINAS OF THE SAN DIEGO REGION

Kenneth Schiff*, Jeff Brown and Dario Diehl. Southern California Coastal Water Research Project, Westminster, CA

Marinas are areas of special water quality concern because of the potential for pollutant accumulation within their protected waters. Perhaps the largest contaminant source to marinas is antifouling paints that leach copper to prevent the growth of encrusting organisms on vessel bottoms. Despite the potential environmental risk in marinas, particularly in San Diego, California, where as many as 17,000 recreational vessels are berthed, very little monitoring of marinas has been conducted. The objective of this study was two-fold: 1) Determine the extent and magnitude of dissolved copper concentrations in marinas throughout the San Diego region, and 2) Determine if elevated copper concentrations in marinas of the San Diego region are resulting in adverse biological impacts. A probabilistic study design was used to sample water-column copper concentrations and toxicity (using Mytilus galloprovincialis) at 30 stations. Results indicated that exceedance of state water quality objectives was widespread (86% of marina area), but that toxicity was much less prevalent (21% of marina area). Toxicity identification evaluations (TIEs) conducted at the most toxic sites indicated that toxicity was largely due to trace metals, most likely copper. Toxicity was reduced using TIE treatments that chelated trace metals such as cation exchange column, ethylenediaminetetraacetic acid (EDTA), sodium thiosulfate (STS). Moreover, increasing dissolved copper concentrations correlated with increasing toxicity and these copper concentrations were high enough to account for virtually all of the observed toxicity.

161 PHYSICAL ASPECTS OF SOUTHERN CALIFORNIA BEACHES AND HOW PEOPLE PERCEIVE THEM: CONSIDERATIONS FOR BEACH NOURISHMENT PLANNING

Scott H. Grove, Sonora High School, La Habra, CA

Beaches are California's number one tourist and recreational destination. This study of Southern California beaches has two parts. Part 1 provides a snap shot of the beaches of Southern California, recording comparative physical properties at intervals along the 200-mile shoreline from Point Conception to the San Diego boarder. Results of the first part of this study show that beaches in Southern California have a dramatic variety of widths as well as sand types, colors, and textures. Part 2 of the study surveys people's opinions of Southern California beaches. To accomplish this, a "Beach Sand Survey" was given to 225 people who were divided into three groups: 1) the public—beach users; 2) coastal resource scientists, agency professionals, and educators; and 3) coastal engineers and geologists. The survey was designed to assess what physical beach factors are considered important. Survey results revealed that people have a wide variety of reasons why they enjoy going to the beach and a wide set of perceptions concerning our beaches. For example: While most prefer moderately wide beaches with fine texture sand, some favor very narrow and pebbly beaches, noting that these types of beaches may be adjacent to the best places for either surfing or tidepooling. The "Beach Sand Survey" also asks whether people are in favor of restoring Southern California beaches using beach nourishment if erosion has unfavorably narrowed them. People had mixed opinions regarding bringing new sand onto the beaches, but with the majority favoring nourishment and the majority willing to pay an extra tax to have their beaches restored.

162 TRANSPLANTED XY SPERMATOGONIA STEM CELLS COLONIZE IN THE SEMINIFEROUS TUBULES OF XXY MICE

B. Chuck, California Academy of Maths and Science. Y. Lue, Department of Medicine, LA-Biomed at Harbor-UCLA Medical Center, Torrance, CA 90502

Klinefelter syndrome (XXY males) is the most common sex chromosome aneuploidy, occurring in about 1.2 per 1000 liveborn male births. An experimental XXY mouse model has been developed and characterized for the purpose of uncovering the molecular mechanism of KS. It has been demonstrated that adult XXY mice have absence of germ cells, decreased serum testosterone levels, elevated serum FSH levels and impaired learning and memory. Furthermore, it has been shown that massive germ cell loss occurs within 10 days after birth, indicating that testicular failure begins early in XXY mice. It was hypothesized that in addition to germ cell defect, Sertoli cell dysfunction may contribute to the spermatogenetic failure in XXY mice. To test this hypothesis, testicular cells from 4–6 wks old transgenic mice (XY) were harvested and engineered to express green fluorescent protein (GFP). These cells were then injected them directly into the seminiferous tubules of adult XXY mice and busulfan-treated recipient testes of wild-type (XY) mice. Ten weeks after transplantation, these recipient mice testes were removed. Decapsulated testes were examined under fluorescence microscopy to detect the GFP labelled cells. Immunohistochemistry was performed for detection of cells with GFP expression. Under fluorescent microscopy, green fluorescence (GFP positive cells) was present within seminiferous tubules of busulfan-treated XY mice, but not in XXY mice. Immunohistochemistry on serial testicular sections demonstrated that GFP positive spermatogonia present in some of the seminiferous tubules of XXY mice, but more abundant in busulfan-treated XY mice. In some recipients, GFP positive Leydig cells were found in the interstitium of both XY and XXY mice. This demonstrates that XY testicular cells transplanted into XXY testes are able to survive for 10 weeks. Donor XY spermatogonia could colonize in the seminiferous tubules and donor Leydig cells reside in the interstitium of XXY testis (presumably arriving through puncture or rupture of tubules). It has been concluded that 1) XXY testicular environment allows XY Leydig cells to seed in the interstitium and 2) XXY Sertoli cells are sufficiently functional for XY spermatogonia to reside in the XXY seminiferous tubules. (Supported in part by LABiomed Seed Grant to Y. Lue.)

163 COUNTING THE MICROINFARCT(S) IN SECTION R-19 OF A HUMAN BRAIN

Huynh, Tommy, Alhambra High School, and Neuroscience Method Research Group, University of Southern California, Department of Neurology, Los Angeles, CA, 90242

Ischemic vascular dementia (IVD) is a relatively uncommon entity, in the course of which multiple ischemic brain lesions result in progressive memory impairment. Ischemic brain lesions may also aggravate the neuropsychologic deficit of Alzheimer disease (AD). The most commonly observed neuropathologic abnormalities were lacunar infarcts and microinfarcts (Vinters, 2000). Microinfarcts are by lesions not visible on gross inspection of the brain slices but are apparent on subsequent microscopic review of the case. Microinfarcts can be easily seen by routine hematoxylin and eosin-stained sections. A method was developed in processing entire sections of the human brain using an Aliquot Mixer, therefore allowing the staining of the tissue. In the nineteenth section of this non-IVD brain, microinfarcts were not prevalent in the diagrammed regions in both the cortical and white matter, thus showing that microinfarcts are not in great numbers in patients without IVD.

164 MUTAGENIC ANALYSIS OF THE CYTOCHROME P450 14α-DEMETHYLASE (CkCyp51p) TO AZOLE RESISTANCE IN *CANDIDA KRUSEI*

Da Eun Im, California Academy of Math and Science. Trang Phan, Hyunsook Park, and Scott G. Filler, Division of Infectious Diseases, Department of Medicine, Los Angeles Biomedical Research Institute at Harbor–UCLA Medical Center, Torrance, CA 90502

Candida krusei is an opportunistic pathogen that can cause serious infections in immunocompromised patients. Because *C. krusei* is intrinsically resistant to azole, this organism is a significant concern with the rise in the use of azole antifungal agents. Our previous study indicates that the main mechanism of fluconazole resistance in *C. krusei* is the alternation in the target enzyme, cytochrome P450 14α-demethylase (*CkCYP51, CkERG16*), which is inhibited by azoles to cause an accumulation of C_{14} methylated sterols that disrupts membrane structure. In this study, we have compared the amino acid sequence of *CkCyp51p,* which is resistant to azoles and *C. albicans* Erg16p, which is azole-susceptible. We hypothesized that the mutation of some amino acid in conserved region makes *C. krusei* become more resistant to azole drug during evolution. To prove this hypothesis, we introduced point mutations in *CkCYP51* by in vitro mutagenesis, potentially changing the active pockets for azole binding. We compared the susceptibility of *Saccharomyces cerevisiae* strains, which expressed these mutated proteins, to voriconazole and fluconazole and that of the strains expressing *CaERG16.* We identified that the protein possessing mutations in *ckCYP51*: Ile437 to Val, Val156 to Phe, and Ile404 to Val caused altered drug sensitivity to twofold more compared to wild type CkCYP51. This result indicates that this region is critically important in governing drug resistance; however, the point mutation may not be enough for diminishing azole-resistance. Further work will involve deletion of the functional domain of *CkCYP51*

165 FACTORS AFFECTING BALANCE AND PCP DISORDERS: THE INFLUENCE OF NATURAL STIMULI IN MICE UTRICLES YEAR 2

D.E. Lluncor, Palos Verdes Peninsula High School and David Geffen School of Medicine at UCLA. Division of Neurobiology Head and Neck Surgery Laboratory of Vestibular/Sensory Neurobiology, Los Angeles, CA 90095

One otolithic organ, the utricle, has otoconia which acts upon the hair cells distinct polarization of cilia, called the morphological polarization vector (MPV). This project examines the effect of otoconia as stimuli upon the MPV orientation. The het/het and tlt/tlt mutation inhibits otoconia formation. When compared to the wild type and het/plus mice, otoconia is the experimental variable. The tissue was prepared and imaged for confocal microscopy. A highly analytical methodology was created to assess precise MPV orientation. The data was collected from twelve mice utricles, totaling 5837 traced MPV angles. Using the independent variable two sample t-test, 78.5% of the 28 het/het and het/plus regions and 68.5% of the 35 tlt/tlt and wild type regions had equal MPVs. The majority of angle distributions were equal, suggesting MPV organization is stimuli independent. This experiment might have specified a class of factors contributing to MPV maintenance.

166 EFFECTS OF STRESS AND EXERCISE IN BRAIN-DERIVED NEUROTROPHIC FACTOR EXPRESSION

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It was previously shown that chronic restraint stress induces an upregulation of activated Bcl-2 Associated protein X (Bax), a molecule that promotes neuronal apoptosis. Exercise served to lower levels of Bax, the reason for which was hypothesized to be elevation in trophic factor expression, in particular brain-derived neurotrophic factor (BDNF). BDNF, markedly expressed in the hippocampus, the part of the brain responsible for spatial learning and memory, is a protein that serves as a neurotransmitter regulator and aids in long-term potentiation and learning. BDNF can also activate phosphatidylinositol 3-kinase, mitogen-associated protein kinase, and other cell survival pathways; it has the potential to protect against stress-induced harm in neurons. In the current study, rat models were subjected to acute stress by immobilization and/or allowed to exercise by a running wheel 14 days prior. Four treatment groups were compared: stress-only, exercise-only, exercise with stress, and control (with neither stress nor exercise). Hippocampal BDNF mRNA levels were analyzed via *in-situ* hybridization. In the CA3 region of the hippocampus, the exercise-only group showed higher BDNF mRNA levels than those of the stress-only group. This comparison is consistent with data from earlier studies in this lab. Also consistent with Bax levels, these data suggest that BDNF plays some role in countering the harmful effects of stress.

169 BIOARTIFICIAL HEART TISSUE: AN ELECTROACTIVE POLYMER FOR CARDIAC PATCHES

Karis R. Tang-Quan, Palos Verdes Peninsula High School, Rolling Hills Estates, CA 90274. Mentor: Dr. Ben Wu, UCLA, Department of Bioengineering, Los Angeles, CA 90095

Tissue engineering seeks to replace heart infarcts with functional engineered heart tissue. The project aimed to study the effects of mechanical and electrical stimulation for engineering cardiac patches. The project investigated further the effectiveness of a polymer and scaffold for cardiac tissue engineering.

Electrospinning of polyurethane (PU) created an elastic scaffold. An electroactive polymer was developed to provide stimulation. Eleven trials of 30 samples of human foreskin fibroblasts (HFF) and cardiomyocytes were cultured. Immunofluorescence and scanning electron microscopy (SEM) were used to collect images.

The design of the polymer is novel but unstable. Morphology and directional orientation of the layers of cells indicate proper cell signaling. The properties of PU are unique to the needs of cardiomyocytes because the fibers participate in contraction with the cells, instead of inhibiting it.

The effects of electrical and mechanical stimulation on cardiomyocytes using an electroactive polymer could not be studied. However, a greater discovery was made in the second part of the project objective—the application of PU as a scaffold. Electrospinning brought out novel advantages to using PU in engineering cardiac patches.

170 MYOSTATIN EFFECT ON BODY COMPOSITION IN GENETICALY MODIFIED MICE

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Purpose: Myostatin (Mst), a member of the TGF-β superfamily, is a negative regulator of skeletal muscle mass. In animals and humans, inactivation of Mst is associated with an increase in skeletal muscle mass while increased levels of Mst result in significant muscle loss. Aging is associated with the increase of Mst levels and fat mass. We hypothesized that the regulation of skeletal muscle and fat mass is partially coordinated by Mst. The purpose of this study was to delineate the role of Mst, and its effect on body composition, using Mst overexpressing transgenic and knock out mice in the age-dependent process.

Methods: Transgenic animals were generated by pronuclei injection of muscle creatine kinase promoter driven Mst cDNA construct into C57/Bl6 inbreed mouse strain. Mst knock out (KO) animals were generated at John Hopkins University. In each study group, we used 5 animals, twelve months of age. Animals were positioned into a MicroCAT II CT scan. The three dimensional reconstructed animals were sliced for quantification and comparison.

Results: The Mst transgenic animals were 10% heavier, had 27% less hind limb muscle mass, and 3.2 time more abdominal fat, compared to controls. The Mst KO mice were 22% heavier, had 67% more hind limb muscle mass, and 70% less abdominal fat mass. To our knowledge, this is the first quantitative demonstration of changes in muscle and fat mass caused by overexpression or inhibition of the Mst protein.

Conclusions: These data suggest that Mst has a remarkable effect on body composition during aging. The consequences of these data may be related with muscle dysfunction, arteriosclerosis, diabetes, and heart failure. With age advancement, individuals lose lean protein tissue and gain adipose tissue. Thus, skeletal muscle protein is particularly susceptible to aging. The animals used in this project may be an excellent model for studying the aging process.

171 HEAT SHOCK PROTEIN 70 (HSP70) EXPRESSION IN MULTIPLE SCLEROSIS

Young, Amy. Alhambra High School, Multiple Sclerosis Research Group. University of Southern California, Keck School of Medicine, McKibben Hall, 1333 San Pablo Street, Los Angeles, CA, 90033

Multiple Sclerosis is an autoimmune disease of the central nervous system which results in significant areas of demyelination, caused by the immune system attacking the myelin, thinking it's a foreign antigen. There are three main neural lineage cell types in the brain; neurons, astrocytes, and oligodendrocytes. Heat shock proteins (Hsp) are essential to the everyday survival of cells but play a significant role in the protection of all cellular proteins following stress, by binding to and ensuring they retain their shape and activity. Hsp can also work as immune stimulators, taking these cellular proteins to the immune system and causing increased immune responses to these proteins.

The data describes the identification of a typical active MS lesion where the demyelination has occurred. In and around this lesion are many mononuclear cells, including macrophages and also a large number of cells expressing one of the major Hsp, namely Hsp70. Using immunofluorescence and immunohistochemistry, I was able to successfully identify the three different lineages of neural cells in the tissues, with differential expression of oligodendrocytes and astrocytes observed on and around the lesions. The ability to detect Hsp70 in and around MS lesions and the staining of different lineages of neural cells provide an important basis for the ongoing research to determining which neural cells overexpress Hsp70 in the MS lesion.

173 EXPOSURE TO HYPEROXIA DURING PERINATAL PERIOD DISRUPTS SPECIFIC PULMONARY ALVEOLAR EPITHELIAL-MESENCHYMAL SIGNALING PATHWAYS

Sanyl Kabre, Hawthorne High School. Sharon Sugano, Dr. John S. Torday, Dr. Virender K. Rehan, Dept. of Pediatrics and Obstetrics & Gynecology, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA

Bronchopulmonary dysplasia (BPD) remains a major cause of morbidity and mortality in the premature infant. Although exposure to hyperoxia is commonly implicated in BPD pathogenesis, the underlying molecular mechanisms remain unclear. There is increasing evidence that lipid interstitial fibroblasts play a key role in injury-repair mechanisms in a variety of organ systems. In the lung, pulmonary interstitial fibroblasts are classified into lipid containing lipofibroblasts and non-lipid containing interstitial cells, myofibroblast, that are located more peripherally in the alveolar septum.

Lipofibroblasts are characterized by the expression of biomarkers, such as *PTHrPR, ADRP,* and *PPARg.* Myofibroblast phenotypes are characterized by the expression of α-SMA and the absence of lipid storage. Although the functional role of pulmonary fibroblasts remain incompletely understood, lipofibroblasts synthesize and secrete growth factors necessary for normal lung growth and development; provide substrate for surfactant phospholipid synthesis, and store neutral lipids that act as antioxidants. In contrast, myofibroblasts play a major role in chronic inflammation and pulmonary fibrosis.

Exposure to hyperoxia exacerbates change from lipofibroblasts to myofibroblasts. Specifically downregulating Platelet Derived Growth Factor (PDGF) mediated alveolar signaling. With excessive mechanical stress to lipofibroblasts, expression of PTHrP-R and other lipogenic markers decreased and lipofibroblasts transdifferntiated to myofibroblast. However, the effect of oxygen exposure on this lipo-to-myofibroblast transdifferntiation is unknown.

Our objective was to examine the effect of O2 on the transdifferentiation of pulmonary lipofibroblasts cultured from preterm and near term fetal lung. Gestational day 18 and 21 fetal rat lung fibroblasts were obtained from time-mated Sprague Dawley rats.

We speculate that this is a critical molecular event underlying the hyperoxic lung injury, and in the pathogenesis of BPD. Further, induction of adipogenic transcription factors may not only prevent but, in fact, reverse the myogenic fibroblast to an adipogenic phenotype.

174 INVESTIGATING PROTOCOLS FOR *HALIOTIS RUFESCENS* EGG CRYOPRESERVATION

Julie A. Guerin. Cabrillo Marine Aquarium, San Pedro, CA 90731; Palos Verdes Peninsula High School, Rolling Hills Estates, CA 90274

The purpose of this study was to investigate cryopreservation protocols which would yield results for normal red abalone (*Haliotis rufescens*) egg phenotype after thawing. The objectives were to determine whether eggs can be successfully cryopreserved using a stepwise cooling and thawing procedure, which cryoprotectant agent (CPA) is most effective, and whether a non-permeating cryoprotectant (sucrose) can aid in the thawing and rehydration process.

After induced spawning and egg collection, four freezing trials were conducted using CPA 'Freezing Medium' (FM) or dimethyl sulfoxide (DMSO) at 8 and 16 mins stepwise gradual cooling and non-stepwise 1 min cooling, before plunging into liquid nitrogen. A total of 45 stepwise and non-stepwise thawing protocols were tested with and without sucrose.

Best results were found in protocols using DMSO at 8 and 16 mins stepwise cooling, and stepwise thawing with sucrose amounts of 1.25g or 2.5g, yielding 25% to 50% (8mins) and 50% to 75% (16mins) normal egg phenotypes. Non-stepwise protocols resulted in 75% to 100% eggs bursting with the remainder abnormal. Thawing protocols without sucrose resulted in 100% eggs bursting. Protocols using FM resulted in 50% to100% eggs bursting, with the remainder abnormal.

Stepwise cooling and thawing, DMSO as CPA, and the use of sucrose in acting as a non-permeating buffer in diminishing effects of rapid rehydration, contribute to maintain normal egg phenotype after cryopreservation, which supports my hypothesis. However, it is unknown whether eggs were still viable. The intention was to verify the survivabilty of eggs with live sperm, but male spawning was unsuccessful. Further research will include *in vitro* fertilization studies, and cryogenic studies on the endangered white and threatened black abalone.

175 MEASURING THE PERCEIVED PREDATION RISKS IN HOUSE FINCHES IN DIFFERENT HABITAT TYPES

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Animals use different strategies to minimize predation risk; such as foraging in tighter groups to benefit from dilution or select habitats with lower abundance of predators to reduce the number of predator-prey interactions. We tested whether two indicators of anti-predator behavior (scanning rate and scan bout duration) of house finch *Carpodacus Mexicanus* were influenced by neighbor distance (0 m, 3 m) and habitat type (less urban, highly urban with human disturbance, highly urban without human disturbance). We conducted this study using semi-natural experiments, which allowed us to manipulate environmental conditions while keeping animals foraging on natural grounds. Preliminary results suggest that house finches are indeed affected by the distance to flock mates, but not by habitat type. When animals forage farther from flock mates, they increase the allocation of time to scanning, probably to increase the chances of detecting potential predators.

176 EFFECTS OF TIDAL FLUCTUATIONS ON THE AVAILABILITY OF NITROGEN COMPOUNDS IN THE LOS ANGELES HARBOR

Sanjit Datta. Palos Verdes Peninsula High School, Cabrillo Marine Aquarium, 3720 Stephen White Drive, San Pedro, CA 90731

Due to high shipping volume in the Los Angeles Harbor and the subsequent pollution of this semi-enclosed environment, the density of life in the Harbor has been steadily decreasing due to a lack of available nutrients. To remedy the problem, active study is needed in order to discover patterns in nutrient concentration fluctuations and to determine what environmental characteristics within an enclosed coastal environment.

This study attempted to correlate changes in tide with concentrations of nitrites in two coastal environments of the Los Angeles Harbor: a boat launch area and a salt marsh. Water samples were collected from these two locations at alternate five-minute intervals and analyzed for nitrite concentrations. These data were compared to a graph of tide height at the time of collection to determine any correlation.

There was no apparent link found between tidal fluctuations and nitrite concentrations. The nitrite concentrations seemed to be relatively randomly distributed, changing by mere thousandths of ppm. However, the nutrient concentrations in the salt marsh fluctuated more than those in the boat launch, suggesting that the boat launch environment would provide a more stable environment for life to grow. However, the almost complete lack of human influence in the salt marsh (something that is not feasible for a busy harbor) has rendered it much more conducive to life. The tides, however, seem to have no effect on the nutrient concentrations.

177 A STUDY OF FECAL INDICATOR BACTERIA (FIB) IN THE BALLONA WETLANDS AND DEL REY LAGOON, LOS ANGELES COUNTY, CALIFORNIA

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Wetland areas and beaches adjacent to them are a great concern due to their interaction and the presence of sources of fecal contamination. The purpose of this study is to compare densities of fecal indicator bacteria (FIB) in tidal water flowing two adjacent aquatic ecosystems, the Ballona Wetlands and Del Rey Lagoon. During four surveys in 2005, each site was sampled during ebb tide flows of spring low tides. Samples were collected inside the Ballona Wetlands and in Del Rey Lagoon. At each site, water quality measurements (temperature, salinity, dissolved oxygen, pH) were made using a YSI 600R sonde, five replicate samples of water were collected for turbidity (HACH 2100N turbidimeter) and FIB determinations and counts of birds feeding or resting on nearby intertidal mudflats were made. FIB were tested for total coliforms and *E. coli* using the Idexx defined substrate test kits (Quantitray-2000 test trays, Colilert-18 media). Bacteria were further characterized using the API 20E Identification System for *Enterobacteriaceae. E. coli* densities were greater in water flowing from the lagoon compare to the wetlands on three occasions, two of which were significantly different ($p < 0.05$). The Del Rey Lagoon was observed to have higher concentrations of water fowl than seen in the main channel of the Ballona Wetlands, so the greater *E. coli* densities in the lagoon may be associated with greater bird densities. Based on the metabolic responses indicated by the API system, the *E. coli* measurements obtained using the IDEXX system may represent a variety of *Enterobacteriaceae* species.

178 ANALYSIS OF PHYSICAL PROPERTIES OF LINEAR ACCELERATORS USING MATHEMATICAL AND EXPERIMENTAL METHODS

J. Luo, Alhambra High School. O.O. Bernal, California State University Los Angeles, Department of Physics, Los Angeles, California, 90032

One of the most interesting applications of magnetism is accelerating objects at tremendous speeds. The two most prominent magnetic accelerators are Gauss Guns and Rail Guns. The research focus lies in analyzing the interaction between the physical dimensions of these accelerators and the projectiles and their influence on the velocity and efficiency to promote specific amplification. This is done both mathematically and experimentally. It was found that the Gauss Gun can be amplified not through an increase of length, but rather by an increase in width. Furthermore, increased resistance in the coils demonstrates higher projectile velocity due to a mathematic model created. The Rail Gun has infinite possible amplification in terms of length due to the ability to continually provide force and acceleration down the rails. Also, the use of different rail compositions alters performance. Carbon rails were found to be most efficient for larger-scale implementation due to sustainability, whereas aluminum and copper rails were best suited for small and medium-scale implementation. In addition, the shape of the launch opening is best designed towards the specific shape of the projectile to create better connectivity. In terms of the projectile, multiple connections made in conjunction with the rails provided more aerodynamic stability and decreased rail erosion.

179 THE NEW AND INNOVATIVE OPTIC ACCELEROMETER SENSOR

R. Purasinghe, Alhambra High School. Dr. Feng and Dr. Kim, University of California Irvine, Department of Structural Engineering, Irvine, CA, 92697

The optic sensor being created is to replace the inaccurate electrical sensor being used today in many fields of engineering due to the fact that its internals cause an altercation in the movement and data it picks up. This altercation happens when the electrical sensor is used in a location with a high abundance of electricity. The two sensors are placed on a shake table that moves at a known acceleration sine value and show the difference in what the optic sensor picks up for the movement. Because the electrical sensor is not near any high current or electricity whilst on the shake table, the electrical sensor's movement read is said to be correct. Thus this will provide two acceleration sine graphs being: the optic sensor's reading of what the movement of the shake table is, and the electrical sensor's reading of what the movement of the shake table is. The graphs of each sine curve are analyzed together, showing where the optical sensor has a natural frequency. The tests show that at 21 hertz, the optic sensor picks up the most vibrations (this particular sensor's natural frequency) and at this movement is the most inaccurate/insufficient. For use of this sensor, more will need to be made but with different masses, so that the natural frequency changes. And a group of sensors with different masses can be used on one location for best results.

180 ATAXIA TELANGIECTASIA AND DOSAGES OF BLEOMYCIN

Sunghye Kim, California Academy of Math and Science. Helen Chun, California State University of Dominguez Hills, Department of Biology, Carson, CA 90747

Ataxia telangiectasia (A-T) is a recessive genetic disease caused by mutations in the gene, ATM (*ataxia telangiectasia,* mutated). Symptoms of this disease include the degeneration of the brain, *telangiectasia* (enlarged blood vessels) around the eyes, lack of muscle coordination, higher chances of developing cancer, a weak immune system, and sensitivity to radiation.

ATM plays a crucial part of the repair process for double-stranded breaks in DNA by finding breaks in DNA strands. In unaffected people, ATM autophosphorylates after DNA breakage, starting a chain of reactions that lead to the phosphorylation of other proteins such as p53, a protein required for the G1 checkpoint. However, for AT patients, ATM does not autophosphorylate and thus p53 is not phosphorylated, meaning that the G1 checkpoint does not occur. DNA is not repaired and can cause damage to the affected patient.

Double-stranded breakage can be caused by radiation. Breakage can also be induced by doses of bleomycin, a drug used in chemotherapy. Bleomycin was used in the experiment to treat white blood cells from normal and A-T affected people. Dosages of bleomycin were changed in order to find the feasible amount of bleomycin should be used in order to prevent overdosage.

182 PERCENT METHYLATION AND ITS RELATIONSHIP WITH AGING

Shelly Tat, Alhambra High School. Dr. Shibata, USC Norris Cancer Center, 1441 Eastlake Ave., Los Angeles, CA 90033, Topping Tower 6410

Aging, tissue deteriorating over time was evaluated using DNA methylation, a level of control, which regulates gene expression by adding a methyl group to cytosine, one of the bases of DNA. By measuring the DNA methylation patterns in buccal cells in the CpG islands of the CSX gene, it is hypothesized that as aging develops, there are numerous incorrect gene expressions causing an increase in DNA methylation patterns. Thus, the goal of this study is to determine an individual's age by calculating the percentage of methylation found in DNA in buccal cells. Using bisulfite treatment, which is necessary to determine the presence of DNA methylation, unmethylated cytosine is converted into uracil in the extracted DNA. DNA extracted buccal cells was amplified by PCR and cloned for reading. Further research and a significant amount of new trials must be performed before accurately concluding whether or not DNA methylation patterns using buccal cells, correlates with one's aging.

183 COMPUTATIONAL ANALYSIS OF GRAINYHEAD-LIKE EPITHELIAL TRANSACTIVATOR (GET1) REGULATED GENES

Madhvi Venkatesh, University High School, Irvine, CA, 92612. Mentors: Bogi Andersen and Ambica Bhandari, University of California, Department of Biological Chemistry, Irvine, CA, 92697

Grainyhead-like epithelial transactivator (Get1/Grhl3) is a conserved mammalian homolog of Grainyhead, which plays an important role in the cuticle development in Drosophila. It has been shown that Get-1 plays a critical role in the terminal differentiation of the skin epidermis and is essential for barrier function in mice. Microarray gene expression analysis of Get-1 knockout mice indicates that it regulates a broad array of epidermal differentiation genes encoding structural proteins, lipid metabolizing enzymes and cell adhesion molecules. In order to identify the direct target genes of Get-1, we looked for potential Get-1 sites conserved in the upstream, downstream and intronic regions of mouse and human genes using the ConSite program. Only those genes that had conserved sites in larger conserved regions were considered for further analysis. We considered only those sites that were also present in significantly conserved regions. We analyzed the top fourty differentially expressed genes from the microarray data. Get-1 binding sites were found in eight upregulated and sixteen downregulated genes, indicating that Get-1 directly regulates some genes involved in epidermal differentiation. The fact that both up and downregulated genes contain Get-1 binding sites suggests that Get-1 can both activate and repress transcription

184 MAKING CAMKIIδA BY THE ADENOVIRUS SYSTEM

Tea, Nicky-Chai, Alhambra High School. Yan Bai, University of Southern California, Institute for Genetic Medicine, Los Angeles, 90033

Breast cancer is the number two leading cause of death in women in the United States. Side effects of Doxorubicin (a chemotherapy used to treat breast cancer) has led to the research that better understands Doxorubicin and its role in the treatment of breast cancer. Using the Adenovirus system, a versatile system involving recombinant adenoviruses, replication of genes that may be involved is further analyzed. By studying *CamIIKδA* it was found that *CamIIKδB* had a completely different result when treated with Doxorubicin. *CamIIKδA* stayed the same, no abnormal regulation while *CamIIKδB* (from previous research), unlike *CamIIKδA* showed to reduce innumerably.

185 PHOTOOXIDATION OF COBALT-BOUND THIOLATO LIGANDS

May Chow, Alhambra High School

Singlet oxygen is the first excited state of oxygen that is a strong electrophile that can react with amino acids, peptides and other biologically relevant molecules. Here we study the oxidation of cobalt-sulfur compounds with singlet oxygen, $^1O_2$, to give the corresponding sulfenato. The cobalt complexes used are (2-mercaptoaniline-*N,S*)(en)$_2$Co(III)tetraflouroborate and (cystamine-*N,S*)(en)$_2$Co(III)tetraflouroborate. Previous studies with organic thiolates have been shown to occur through a hydroperoxy intermediate. The quenching rates (K_T) were measured by time-resolved laser spectroscopy experiments. The quenching rate of these Co compounds is $\sim 10^{-8}$ $M^{-1}s^{-1}$, while the organic compounds have a rate in the range of 10^{-4}–10^{-6} $M^{-1}s^{-1}$. However, it has been found that this intermediate can be stabilized by hydrogen bonding, which should affect the rate reaction. Therefore, we measured the rates of reaction with singlet oxygen in three solvents of decreasing polarity: methanol (CD_3OD), dimethyl formamide (DMF), and water (D_2O). Results show that protic solvents significantly lower the rate of initial attack by singlet oxygen on the thiolato moiety, but conversely increase the rate of product formation from the peroxidic intermediate.

186 THE EFFECTS OF THE HSR-OMEGA GENE IN DROSOPHILA MELANOGASTER

William Martin, Alhambra High School, Benzer Lab, California Institute of Technology, Pasadena, CA, 91125

In my project, I use the fruit fly Drosophila melanogaster to study the creosote phenotype. The creosote phenotype is an inability to function due to a diet containing over nutrition. I study the genes that cause this creosote phenotype in the fruit fly and in my project the gene I am studying is HSR-

Omega. The HSR-Omega gene is an unusual non-protein-coding gene with multiple transcription products dynamically expressed in most cell types of Drosophila melanogaster and it is a member of the heat shock gene family. This gene has vital functions during times of stress. In my project, I test the effects of this gene by doing crosses under flies with certain P-Elements. In doing this project, I discovered that the P-element EP3269 does cause an expression of the creosote phenotype, but is not associated with the HSR-Omega gene.

187 FUNCTIONAL ANALYSIS OF THE MBNL3 PROTEIN

Dan Qing Yan, Alhambra High School, University of Southern California, Institute of Genetic Medicine, Los Angeles, CA 90033

DM1 (muscular dystrophy) is a neuromuscular disease associated with myotonia, caused by expanded CTG repeats in the 3′ untranslated region (UTR) of the DM protein kinase (DMPK) gene. The expanded repeats aggregate within the nucleus as foci where several proteins bind to that repeats. MBNL3 muscleblind protein is one of these proteins found in the nuclear foci. In this context, to better understand the mechanism of the DM disease, characterization of MBNL3 is necessary. The protein will be produced using Adenovirus system as it is the most efficient and versatile system for producing this type of protein. The harvested proteins will then be expressed in muscle tissues, in vitro; to test the effects it has on Myotonic Dystrophy. The produced cells expressed in muscle tissue cells showed that MBNL3 has substantial effect on the disease and plays a critical role in the maintenance of DM1 integrity.

Alphabetical List of all Presenters.

Name	Abstract No.
Gar Abbas	46,76
Joseph Abellera	77
M. James Allen	49
Tony Andrady	3
Rich Anthony	124
Amy J. Arispe	78
Joan M. Backey	32
Howard C. Bailey	156, 157
Suzanne M. Baltzer	79
Dustin Bambic	55
Jonathan N. Baskin	44
Steven M. Bay	70
Chris Beegan	66
S.H.Bryant	45
Leslie J. Buena	80
Erick Burres	71
Chris Cagle	64
Mark H. Capelli	127
David A. Caron	59
Ivona Cetinic	63
Hee San Choi	139
May Chow	185
Brenton Chuck	162
Wesley Chun	117
Damien K. Cie	15
Molly Colvin	81
Gerry Del Rio Cortes	83
Nat Cox	38
Neven Dabbousi	82
Sanjit Datta	176
Jessica DeGiacomo	84
Russell V. Di Fiori	85
Xin Deng	145
Sarah Douglass	86
Sabrina Drill	87, 128
Dent A. Earl	28
Matthew Edwards	17
Marcus Eriksen	8
Edward L. Ervin	132
Richard Evans	61
Mark E. Fenn	152
Ryan Ferrer	50
Alyssa Floyd	29
David G. Foley	119
Tom Ford	18
Amy Frame	8
Bridgette Froeschke	27
Samantha Galasso	88
Jay Gan	153
David J. Germano	136
Lisa Gilbane	75
Scott H. Grove	161
Julie A Guerin	89,174
Thomas R. Haglund	130
Ibrahim Hajjali	90
Lisa Haney	10
Oce. A. Raul H. Gutierrez	91
Cynthia Hitchcock	131
Tim E. Hovey	129
Wesley S. Hunter	115
Tommy Huynh	163
Da Eun Im	164
W. James Ingraham	120
Andrew Jahn	12,13
Erica T. Jarvis	92
Burton Jones	56
Laura Jones	135
Helen YH Jung	51
Sanyl Kabre	173
Julianne E. Kalman	94, 34
Kurt Karageorge	95
Susan Kaveggia	62
Robin J. Keber	96
Thomas Keegan	48
Carol Keiper	6
Kevin Kelley	143
Sunghye Kim	180
Jo Kitz	39
Carl Kloock	36
Gregg W. Langlois	65
Jarrod Larson	35,93,97
Gwen Lattin	2
Jane Lee	98
Jeong Hee Lim	155
Sharon Lin	149
Diana Lloyd	33
David Lluncor	165
Kerri Loke	23
James Luo	178
Henry Luu	166
Ellen Mackey	41
Karen Martin	74
William Martin	186
Paul Matson	16
Juli Matsumoto	99
Mike McCarthy	25
Anthony Metcalf	138
Eric Miller	22
Charles Moore	118
Shelly Moore	7
Nima Moradian	100
A Kimo Morris	24
Sarah S. Mosko	9
Christopher Mull	30
Michael O. Navarro	101
Nicolay P. Nezlin	57
Jennifer Nguyen	14
Mae Grace Nillos	116
Christopher T. Oakes	21
Joshua D. Olson	102
Joan Marie Ordonez	103
Melva R. Osequera	104
Carl Page	47
Rick L. Perry	142
Susanne Plank	105
Daniel Pondella II	19
Sean A. Porter	52
Taylor L. Pupka	106
Ruwanka Purasinghe	179
G. Ramachandraiah	123
Ananda Ranasinghe	68
Stewart Reid	25
Kristen N. Reifel	58
Mary Ann Rempel	144
Jesus Reyes	146
Kristine L. Richardson	107
Lorena M. Rios	121
Kerry J. Ritter	69
Gabriela Rodriguez-Fuentes	158
Rob Roy	72
John Rudolph	159, 54
Rosa M. Runcie	31
Moy McKayla Sab	108
Lisa D. Sabin	154
John Saurenman	148
Kenneth Schiff	160
Daniel Schlenk	147
Astrid Schnetzer	60
Norman J. Scott	133
Erin M. Seale	109
Jane Shevtsov	110
Craig Shuman	20
Deepak Singh	175
Jason Smith	141
Anthony P. Spina	126
Eric Stein	42
Glenn R. Stewart	137
Jennifer Stroh	73
Camm Swift	43
Hideshige Takada	122
Karis Tang-Quan	169
Shelly Tat	182
Nicky-Chai M. Tea	184
Christopher Thellen	5
L.L. Tiefenthaler	53
Kent Trego	11
Ashley E. Varnell	111
Amy Vaux	112
Madhvi Venkatesh	183
Lynne Wetmore	113
Carmen White	151
Mark Whitter	40
Jonathan P. Williams	26
Carl Wirsen	4
Dave Witting	150
Daniel Wu	170
Dan Qing Yan	187
Swati Yanamadala	114,177
Amy Young	171
Diana Young	67
Ann Zellers	1

CONTENTS

Future Meetings .... inside front cover

Acknowlegements .... inside front cover

SCAS Officers .... inside front cover

Reasearch Training Program .... inside front cover

Student Award Winners 1

Schedule of Program for 2006 Annual Meeting 2

Abstracts, in program order 19

Alphabetical list of Presenters at 2006 Annual Meeting .... inside back cover

COVER: Seal of the Academy.

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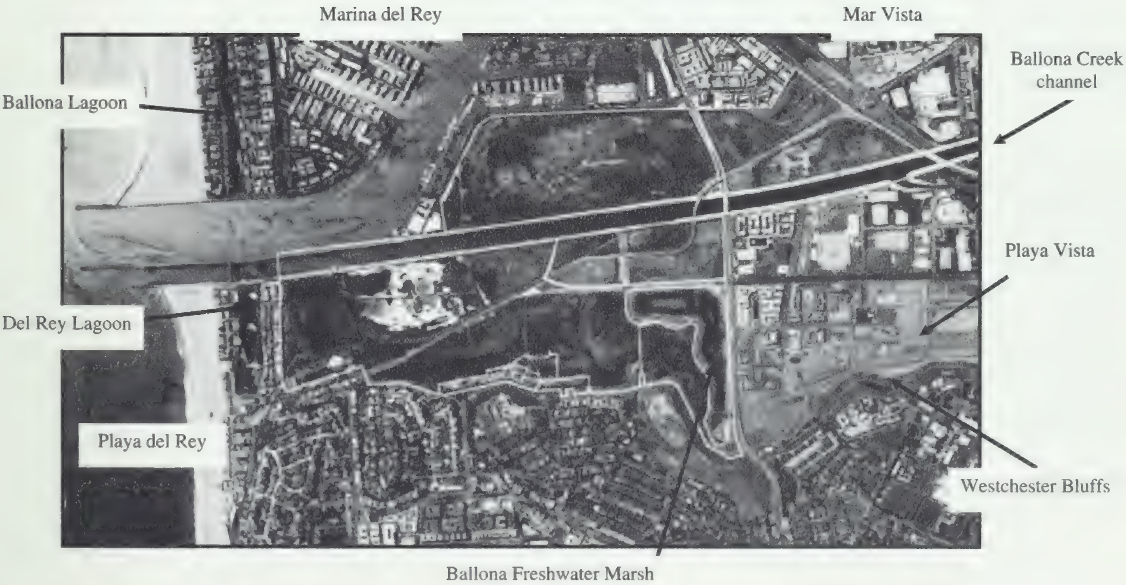
ISSN 0038-3872

SOUTHERN CALIFORNIA ACADEMY OF SCIENCES

BULLETIN

Volume 105

Number 3


Marina del Rey
Mar Vista
Ballona Lagoon
Ballona Creek channel
Playa Vista
Del Rey Lagoon
Playa del Rey
Westchester Bluffs
Ballona Freshwater Marsh

BCAS-A105(3) 91–144 (2006)

December 2006

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Annual Meeting of the Southern California Academy of Sciences

California State University, Fullerton
June 1–2, 2007

FIRST CALL FOR SYMPOSIA AND PAPERS

The Southern California Academy of Sciences will hold its annual Meeting for 2007 on the campus of California State University, Fullerton Friday and Saturday June 1–2.

Presently the following symposia are in the planning stages. If you would like to organize a Symposia for this meeting, or have suggestions for a symposia topic, please contact John Dorsey at jdorsey@lmu.edu or Brad Blood at bblood@psomas.com. Organizers should have a list of participants and a plan for reaching the targeted audience.

Proposed Symposia for 2007

Southern California Archaeology and Paleontology: Andrea Murray; amurray@exchange.fullerton.edu

Ecology of Nearshore Reefs: Daniel Pondella; pondella@oxy.edu and Bob Grove; grovers@sci.com

Avian biology; Kathy Keane; keanebio@cs.com

Red Tides: John Dorsey; jdorsey@lmu.edu

Parasitology: Don Buth; dbuth@ucla.edu

Aquatic Invasive Species: Sabrina Drill; sldrill@ucdavis.edu

Contributed Papers and Posters: Both professionals and students are welcome to submit abstracts for a paper or poster in any area of science. Abstracts are required for all papers, as well as posters, and must be submitted in the format listed on the society webpage. Maximum poster size is 32 x 40 inches.

In addition **Junior Academy members** will submit papers for Saturday sessions.

Abstracts of presented papers and posters will be published as a supplement to the August issue of the Bulletin.

Student Awards: Students who elect to participate are eligible for best paper or poster awards in the following categories: ecology and evolution, molecular biology, genetics and physiology, and physical sciences. In addition the American Institute of Fishery Research Biologists will award best paper and poster in fisheries biology. A paper by any combination of student and professional co-authors will be considered eligible provided that it represents work done principally by student(s). In the case of an award to a co-authored paper, the monetary award and a sone year student membership to the Academy will be made to the first author only.

For further information on posters, abstracts, registration and deadlines, see the Southern California Academy of Science web page at http://scas.jsd.claremont.edu/

Bull. Southern California Acad. Sci.
105(3), 2006, pp. 91–112

Annotated checklist of extirpated, reestablished, and newly-colonized avian taxa of the Ballona Valley, Los Angeles County, California

Daniel S. Cooper

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Abstract.—Successful ecological restoration depends on a clear understanding of the history of local species loss and colonization. One area of California where this can be uniquely achieved is the Ballona Wetlands, one of the best-studied coastal habitats in the state, recently acquired by the State of California for restoration and protection as a proposed Ecological Reserve. Though birds are among the primary beneficiaries of this effort, the avifauna of Ballona Wetlands has not been critically examined in more than 60 years. In an effort to guide future restoration projects, I present a review of bird taxa that have been extirpated, reestablished or that have newly colonized the Ballona area since 1900. This information should facilitate the development of target species to be monitored as the Ballona ecosystem is restored, and should help set local and regional restoration goals.

The Ballona Valley, a large remnant open space area at the mouth of Ballona Creek that includes the Ballona Wetlands in southwestern Los Angeles County, is currently receiving an unprecedented infusion of funding for land acquisition and habitat restoration, coincident with the start of construction on a 462-acre housing and commercial development ("Playa Vista"). In 2003, the California Wildlife Conservation Board acquired 483 acres—a little less than half the open space that remained in the valley through the 1990s—for conservation, including all the remaining intact salt marsh (Trust for Public Land 2003). This belatedly fulfilled a dream of local conservationists, birders, and public officials who have advocated for its protection since at least the early 1900s (Ellis 1926; Cooke 1946; Fuller 1955; Hise and Deverell 2000:220). As restoration projects to recreate or emulate historical natural conditions proceed, knowledge of the current and historical bird community is essential in determining appropriate restoration and conservation goals. Previous efforts at restoring degraded natural communities in the Ballona area have been marked by confusion over the composition of historical plant communities as well as their distribution across what is now a seriously degraded and much-diminished landscape (see Longcore et al. 2000).

Though much of the proposed restoration at Ballona has sought to improve conditions for birds (e.g., NAS 1986), synthesized information on the occurrence of birds and the composition of bird communities at Ballona is surprisingly sparse, being limited to a handful of unpublished surveys of varying quality. Not since the early 1940s (von Bloeker 1943) has any attempt been made to analyze the records of local birders and collectors (either unpublished or published). Drawing from historical and current sources, including museum records and field notes of experienced observers, I present a list of regularly occurring species, and provide detailed accounts for species known to have been lost in the Ballona Valley since the early 1900s, those that have since reestablished populations, and those that have newly colonized the Ballona Valley as nesting or wintering species. Knowledge of this avifaunal change at Ballona should help establish benchmarks of successful restoration, and may serve as an example for reconstruction of lost natural communities elsewhere.

Methods and Site Description

The term "Ballona Valley" here refers to the lowlands from the Westchester Bluffs north across Ballona Creek to the rise in elevation that roughly follows Washington Blvd. in the Venice and Mar Vista neighborhoods of Los Angeles (see Fig. 1). I identify the 10-lane 405 Freeway as the eastern boundary, and thus include the communities of Marina del Rey, Mar Vista, Playa Vista and Playa del Rey. Historical collecting sites within the Ballona Valley include "Port Ballona" (an early bluff-top community at the northern end of the El Segundo Dunes just south of Playa del Rey c. 1880s, *per* Robinson 1939); "Ballona Harbor" (now Playa del Rey); "Del Rey" (now Mar Vista, *per* Robertson 1990); and "Venice Marshes" (presumably the northern portion of historic wetlands now covered by Marina del Rey, east of Venice). Modern birding areas were described by Cooper (2005d).

I consider taxa to be current breeders if one or more pairs have nested successfully for at least two consecutive years. Likewise, I consider winter residents to be any taxa for which two or more individuals have been present through the winter months for at least two consecutive years in the past five years. In one case (Elegant Tern) I consider the species to be a non-breeding summer resident, since large numbers (hundreds) are present continuously from early spring through fall. Taxa are considered "extirpated" if they once maintained consistent breeding or non-breeding populations in the Ballona Valley but no longer do. "Reestablished" taxa have been extirpated in at least one role (winter, summer or both) for a period of several decades, but have resumed breeding, summering and/or wintering since the mid-1900s (the start of consistent record-keeping). "Colonists" are defined as any taxa that have established a consistent breeding or wintering population since the mid-1900s (and that occurred only as transients or vagrants, if at all, prior to this).

Because of the lack of standardized historical survey data during migration periods, taxa known only as transients are not treated here (see Cooper 2005c for a complete checklist), even though it is clear that many birds scarce or absent today were once frequently observed transients (e.g., Fulvous Whistling-Duck *Dendrocygna bicolor*). I also omitted the Great Horned Owl *Bubo virginianus,* given its strongly nocturnal habits. I do not treat the distinctive avifauna of the outer jetties, the breakwater, and the inshore marine environment at Playa del Rey, nor do I include the avifauna of residential Westchester on the bluffs to the south of the Ballona Valley, which, owing to its mature trees and landscaping, has developed a woodland-like avifauna distinct from that of the Ballona Valley (e.g., wintering Townsend's Warbler *Dendroica townsendi* and Dark-eyed Junco *Junco hyemalis*).

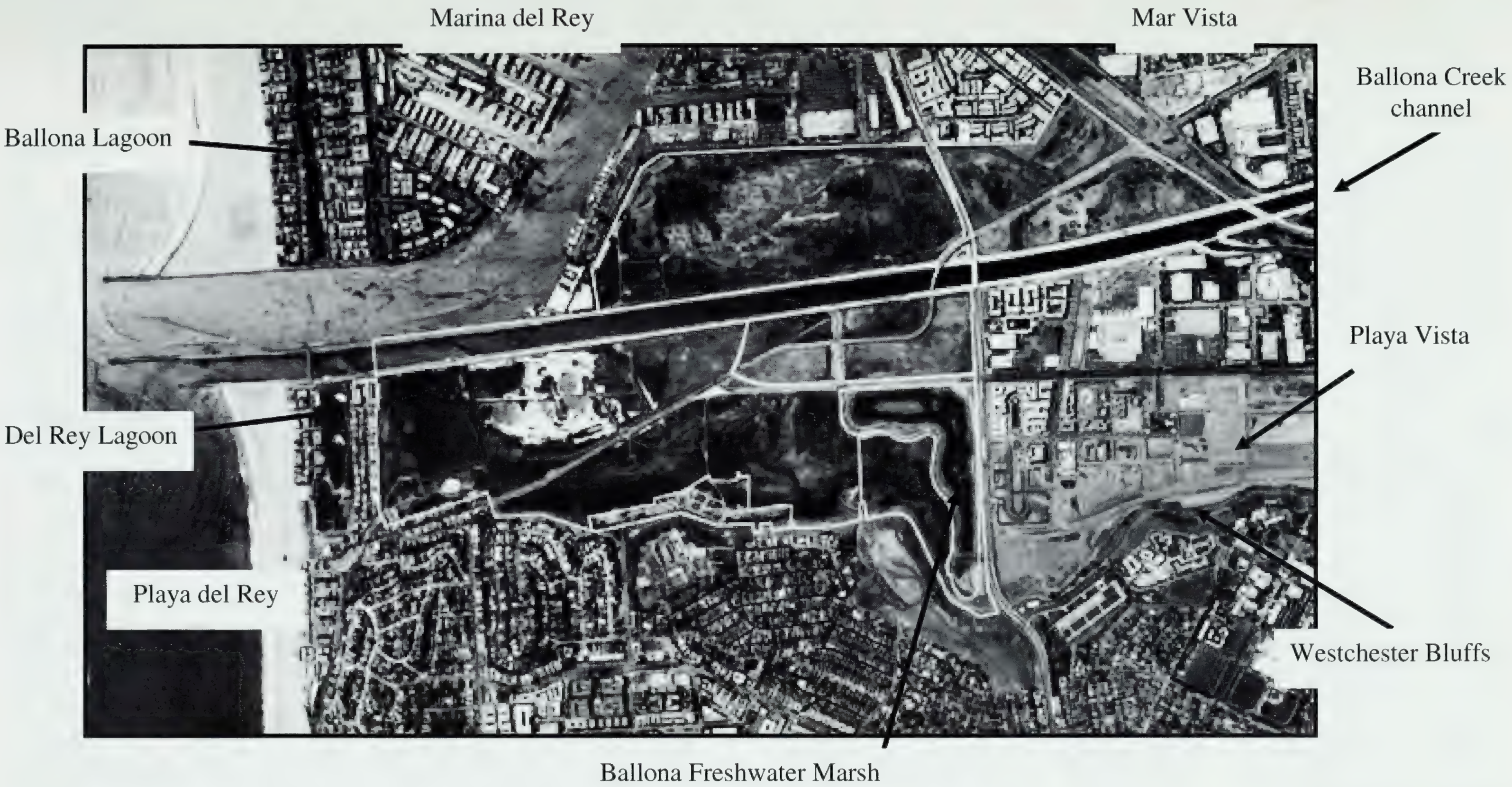
Marina del Rey
Mar Vista
Ballona Creek channel
Ballona Lagoon
Playa Vista
Del Rey Lagoon
Playa del Rey
Westchester Bluffs
Ballona Freshwater Marsh

Fig. 1. Aerial veiw of western Ballona Valley. This image shows open space recently acquired by the state of California near the mouth of Ballona Creek, as well as birding locations mentioned in the text. The boundaries of the study area extend east 2 km to the 405 Fwy. The "Ballona Wetlands" is the large open area in the center of map, north and south of the Ballona Creek channel. The main salt pan is visible as a large whitish patch at center left.

Table 1. Summer, winter and year-round resident birds of the Ballona Valley (excludes transients). An asterisk (*) indicates consistent recent breeding.

Year-round residents

Gadwall *Anas strepera*
*Mallard *Anas platyrhynchos*
Cinnamon Teal *Anas cyanoptera*
*Ruddy Duck *Oxyura jamaicensis*
*Pied-billed Grebe *Podilymbus podiceps*
Brown Pelican *Pelicanus occidentalis*
Double-crested Cormorant *Phalacrocorax auritus*
Least Bittern *Ixobrychus exilis*
*Great Blue Heron *Ardea herodias*
Great Egret *Ardea alba*
Snowy Egret *Egretta thula*
*Green Heron *Butorides virescens*
*Black-crowned Night-Heron *Nycticorax nycticorax*
Cooper's Hawk *Accipiter cooperii*
*Red-tailed Hawk *Buteo jamaicensis*
*American Kestrel *Falco sparverius*
*American Coot *Fulica americana*
*Killdeer *Charadrius vociferus*
*Black Oystercatcher *Haematopus bachmani*
*Black-necked Stilt *Himantopus mexicanus*
Western Gull *Larus occidentalis*
Caspian Tern *Sterna caspia*
*Rock Pigeon *Columba livia*
Spotted Dove *Streptopelia chinensis*
*Mourning Dove *Zenaida macroura*
Rose-ringed Parakeet *Psittacula krameri*
Barn Owl *Tyto alba*
*Great Horned Owl *Bubo virginianus*
*White-throated Swift *Aeronautes saxatalis*
*Anna's Hummingbird *Calypte anna*
*Allen's Hummingbird *Selasphorus sasin*
*Black Phoebe *Sayornis nigricans*
*Cassin's Kingbird *Tyrannus vociferans*
*Western Scrub-Jay *Aphelocoma californica*
*American Crow *Corvus brachyrhynchos*
Common Raven *Corvus corax*
*Tree Swallow *Tachycineta bicolor*
*Bushtit *Psaltriparus minimus*
*Northern Mockingbird *Mimus polyglottos*
*European Starling *Sturnus vulgaris*
*Common Yellowthroat *Geothlypis trichas*
*California Towhee *Pipilo crissalis*
*"Belding's" Savannah Sparrow *Passerculus sandwichensis beldingi*
*Song Sparrow *Melospiza melodia*
*Red-winged Blackbird *Agelaius phoeniceus*
*Western Meadowlark *Sturnella neglecta*
*Brewer's Blackbird *Euphagus cyanocephalus*
*Great-tailed Grackle *Quiscalus mexicanus*
*House Finch *Carpodacus mexicanus*
*Lesser Goldfinch *Carduelis psaltria*
*House Sparrow *Passer domesticus*
*Orange Bishop *Euplectes franciscanus*

Winter Residents

American Wigeon *Anas americana*
Northern Shoveler *Anas clypeata*
Northern Pintail *Anas acuta*
Green-winged Teal *Anas crecca*
Redhead *Aythya americana*
Ring-necked Duck *Aythya collaris*
Greater Scaup *Aythya marila*
Lesser Scaup *Aythya affinis*
Surf Scoter *Melanitta perspecillata*
Bufflehead *Bucephala albeola*
Red-breasted Merganser *Mergus serrator*
Pacific Loon *Gavia pacifica*
Common Loon *Gavia immer*
Horned Grebe *Podiceps auritus*
Eared Grebe *Podiceps nigricollis*
Western Grebe *Aechmorphorus occidentalis*
Brandt's Cormorant *Phalacrocorax penicillatus*
Pelagic Cormorant *Phalacrocorax pelagicus*
White-tailed Kite *Elanus leucurus*
Sharp-shinned Hawk *Accipiter striatus*
Merlin *Falco columbarius*
Peregrine Falcon *Falco peregrinus*
Virginia Rail *Rallus limicola*
Sora *Porzana carolina*
Common Moorhen *Gallinula chloropus*
Black-bellied Plover *Pluvialis squatarola*
Greater Yellowlegs *Tringa melanoleuca*
Willet *Catoptrophous semipalmatus*
Wandering Tattler *Heteroscelus incanus*
Spotted Sandpiper *Actitis macularius*
Whimbrel *Numenius phaeopus*
Marbled Godwit *Limosa fedoa*
Ruddy Turnstone *Arenaria interpres*
Black Turnstone *Arenaria melanocephala*
Surfbird *Aphriza virgata*
Sanderling *Calidris alba*
Western Sandpiper *Calidris mauri*
Least Sandpiper *Calidris minutilla*
Dunlin *Calidris alpina*
Long-billed Dowitcher *Limnodromus scolopaceus*
Wilson's Snipe *Gallinago gallinago*
Mew Gull *Larus canus*
Ring-billed Gull *Larus delawarensis*
California Gull *Larus californicus*
Herring Gull *Larus argentatus*
Thayer's Gull *Larus thayeri*
Glaucous-winged Gull *Larus glaucescens*
Heermann's Gull *Larus heermanni*
Bonaparte's Gull *Larus philadelphia*
Royal Tern *Sterna maxima*
Belted Kingfisher *Ceryle alcyon*
Northern Flicker *Colaptes auratus*
Say's Phoebe *Sayornis saya*
Loggerhead Shrike *Lanius ludovicianus*
House Wren *Troglodytes aedon*
Marsh Wren *Cistothorus palustris*

Table 1. Continued.

Winter Residents (Continued)

Ruby-crowned Kinglet *Regulus calendula*
Blue-gray Gnatcatcher *Polioptila caerulea*
Hermit Thrush *Catharus guttatus*
American Pipit *Anthus rubescens*
Orange-crowned Warbler *Vermivora celata*
Yellow-rumped Warbler *Dendroica coronata*
Savannah Sparrow (migratory races) *Passerculus sandwichensis*
"Large-billed" Savannah Sparrow *Passerculus sandwichensis rostratus*
Lincoln's Sparrow *Melospiza lincolnii*
White-crowned Sparrow *Zonotrichia leucophrys*
Golden-crowned Sparrow *Zonotrichia atricapilla*
American Goldfinch *Carduelis trisis*

Summer Residents

Elegant Tern *Sterna elegans*
*Least Tern *Sterna antillarum*
*Western Kingbird *Tyrannus verticalis*
*Northern Rough-winged Swallow *Stelgidopteryx serripennis*
*Cliff Swallow *Petrochelidon pyrrhonota*
*Barn Swallow rustica
*Brown-headed Cowbird *Molothrus ater*
*Hooded Oriole *Icterus cucullatus*
*Bullock's Oriole *Icterus bullockii*

Results and Discussion

A list of known regularly wintering, summering, and year-round resident birds in the Ballona Valley is presented in Table 1. Between the early 1900s and spring 2005, the data indicate that 38 taxa were extirpated from the Ballona Valley in at least one role, with 11 having since become reestablished in one or more roles. Twenty-two species have newly colonized the Ballona Valley either as summer or winter residents, including four non-native taxa. Ten species considered "data-deficient" may have maintained populations at Ballona prior to 1900 but are known only from scattered reports or specimens; several were treated as present by von Bloeker (1943) but are possibly attributable to the adjacent El Segundo Dunes, described below.

In the following species accounts, current local status is followed by historical status. Species order follows the American Ornithologists' Union Checklist of North American Birds (A.O.U. 1998) and the most recent supplement (A.O.U. 2004). Standard abbreviations for museums are LACM (Natural History Museum of Los Angeles County), MVZ (Museum of Vertebrate Zoology, University of California, Berkeley), and WFVZ (Western Foundation of Vertebrate Zoology, Camarillo, California). Other frequently-used abbreviations include BFM (Ballona Freshwater Marsh at Playa Vista, constructed 2003), CBC (Christmas Bird Count), LACBBA (Los Angeles County Breeding Bird Atlas, data housed at LACM), and PdR (Playa del Rey, exact location unspecified). Where possible, sight records are included only if published in Audubon Field Notes/(North) American Birds (hereafter "AFN") or in the Western Tanager ("WT"), or if the observer is known to the author.

A handful of dedicated observers have kept field notes from regular visits to the study area for 5+ years, including Kimball L. Garrett (KLG; early 1970s to present), Robert Shanman (RSh; monthly from 1977 to 1987) and Art Pickus (AP; 1993 to 1998) along lower Ballona Creek; Barbara O. Courtois at the western Ballona Wetlands (BOC; 1998 to present); Chuck and Lillian Almdale at Ballona Lagoon (CLA; monthly from 1996 to present); and Russell and Dorothy Stone in the Westchester/Playa Vista area (RDS; 1996 to present). Other observers who have contributed numerous previously unpublished sight records to me directly, or to Kimball L. Garrett ("LACM files"), are cited below by name, or in the case of regular contributors Richard Barth, David Bell, Kevin Larson and Don Sterba, by initials.

Extirpated and Reestablished Taxa

Brant *Branta bernicla.* Extirpated as a winter resident; now an occasional spring transient (1–2/yr. early Feb.—late May); casual in summer and winter. Several spring sightings have involved birds in the tidal channels of the Ballona Wetlands (including a group of six on 03 Apr. 2001, BOC), indicating that Brant may still occasionally attempt to use Ballona as a stopover site. Two summer/fall records include sick or injured birds in 1980 (H. Brodkin, LACM files) and 1996 (DS). The Brant was historically much more common along the coast of southern California with birds in Los Angeles County wintering on kelp beds just offshore (Willett 1912, 1933), a phenomenon that no longer occurs. Though omitted by von Bloeker (1943), this may have been an oversight; groups of up to 12 birds attempted to winter at Ballona as late as the 1950s (WT 12:22; AFN 5:225; WT 18:23; AFN 7:234), and singles were recorded on the Los Angeles CBC through the 1950s (NAS 2002). One modern (post-1950s) wintering attempt involved what was presumably the same bird on 03 Dec. 2002 (BOC) and 12 Jan. 2003 (KL).

Northern Shoveler *Anas clypeata.* Extirpated, then reestablished as a winter resident; currently fairly common in fall and winter at BFM; uncommon to rare elsewhere. Since the creation of BFM in 2003, fall transients have appeared at the end of August in 2003 and 2004, building to several dozen birds by midwinter (Cooper 2005a). I observed dozens feeding on the flooded saltpan of the Ballona Wetlands after heavy rains in Jan. 2005. The Northern Shoveler was not recorded by von Bloeker (1943) but was likely overlooked; early authors (e.g., Grinnell 1898, Willett 1933) have it common or abundant throughout coastal southern California, and a count of 200 presumably wintering birds was made at PdR on 05 Feb. 1947 (WT 13:28). A dramatic decline in the Ballona Valley apparently occurred after the 1950s (Table 2), and between the early 1970s and 2003, the species was recorded just eight times (RSh, KLG, AP).

Northern Pintail *Anas acuta.* Extirpated as a breeding resident; reestablished as a winter resident; now uncommon in migration and winter. The first southbound birds trickle through in late August (two along Ballona Cr. 21 Aug. 2004, KL), and up to 10 remained through the winter 2003–04 (but were rare the following winter, Cooper 2005a). The status of the pintail in winter and migration has changed dramatically from its being historically very numerous ("abundant winter visitor on salt marsh lagoon," von Bloeker 1943), declining through the late 1900s, then back to being irregularly present, albeit in greatly reduced numbers, at BFM. Examples of historical numbers include 2000 birds at a local gun club with freshwater impoundments in late summer 1952 (WT 19:4); and 1000 birds along Ballona Cr. on 12 Oct. 1953 (WT 20:15) and 04 Jan. 1954 (WT 20:30). This species was also historically more common offshore during migration (e.g., AFN 2:189), and it apparently nested in the historical Ballona Wetlands (Willett 1933). Though the Northern Pintail was still being recorded in large numbers on the Los Angeles CBC in the 1970s (NAS 2002), there are just seven known records between the 1950s and 2003.

Table 2. Detection of selected species on the Los Angeles Christmas Bird Count, 1940–present (NAS 2002).

Species	# of CBCs per decade when recorded (high count in parentheses)					
	1940s	1950s	1960s	1970s	1980s	1990s
Gadwall	5 (8)	1 (2)	2 (3)	1 (2)	0	6 (19)
Northern Shoveler	10 (533)	10 (2501)	8 (45)	3 (5)	2 (3)	2 (8)
Northern Pintail	10 (1362)	10 (20,429)	8 (110)	10 (480)	4 (16)	5 (9)
Redhead	6 (14)	6 (4)	6 (20)	5 (10)	1 (1)	0
American Bittern	9 (3)	1 (3)	2 (3)	2 (10)	1 (2)	2 (1)
White-faced Ibis	2 (15)	0	0	0	0	0
Northern Harrier	10 (9)	8 (24)	4 (3)	4 (4)	2 (4)	7 (2)
Clapper Rail	8 (3)	3 (1)	1 (1)	0	0	0
Pacific Golden-Plover	2 (3)	0	5 (7)	5 (3)	2 (1)	0
Snowy Plover	7 (71)	10 (114)	9 (70)	4 (32)	2 (2)	3 (2)
American Avocet	10 (200)	9 (176)	6 (41)	2 (1)	3 (6)	1 (1)
Long-billed Curlew	9 (18)	7 (17)	5 (3)	4 (6)	2 (1)	3 (2)
Burrowing Owl	4 (3)	5 (3)	7 (2)	10 (10)	4 (5)	2 (1)
Short-eared Owl	5 (2)	6 (4)	5 (4)	3 (5)	1 (2)	1 (1)
Allen's Hummingbird	0	0	0	5 (2)	8 (16)	10 (116)
Horned Lark	7 (600)	5 (47)	4 (43)	10 (145)	0	0
European Starling	0	0	10 (1900)	10 (4929)	9 (1579)	10 (2109)
"Large-billed" Savannah Sparrow	10 (7)	2 (5)	0	0	0	0

Cinnamon Teal *Anas cyanoptera.* Extirpated as a breeding resident; colonized as a winter resident; now a fairly common transient and winter resident on freshwater (mid-Aug.–May); uncommon in mid-summer. At BFM, fall migrants arrive in mid-August (a high of 25 by the end of August 2003, DSC) and remain in variable numbers through May (but have not yet bred). This teal apparently nested at Ballona during the early 1900s "in the salt marsh" (von Bloeker 1943), which would have included brackish wetlands and tule-lined ponds, but apparently had been reduced to a transient by the 1920s (Bird-Lore 26:347). Between the early 1900s and the construction of BFM in 2003 recorded only in early spring (up to 30 late Jan.—mid. Mar.) and fall (4 records Sept.–Nov.), with an anomalous sighting on 14 May 1998 (AP).

Canvasback *Aythya valisineria.* Extirpated as a winter resident; two modern records of singles at PdR on 12 Jan. 1985 (RSh) and at BFM on 05 Oct. 2003 (DSC). Von Bloeker (1943) considered the Canvasback "fairly common in winter on the salt marsh lagoon," a reference to the water body at the mouth of Ballona Cr. that was subsequently reduced in size and transformed to Del Rey Lagoon and Ballona Lagoon. The only other local mention is of an individual within a mixed-species raft of waterfowl in the ocean just off Playa del Rey (including Scaup, Northern Shoveler, Northern Pintail and Ruddy Duck) on 11 Dec. 1925 (Bird-Lore 27:22).

Redhead *Aythya americana.* Extirpated, then reestablished as a winter resident; now uncommon in fall and winter. Von Bloeker considered this species "occasional in winter on the salt marsh lagoon" (1943). Oddly, Grinnell (1898) termed Redhead "tolerably common in summer" in coastal Los Angeles Co., but this may have been a misprint for "winter," (which he did not mention) when more expected in the region (see Willett 1912, 1933). From the early 1900s until the creation of BFM, the Redhead was known from just a handful of records Dec.–Feb. (WT 16:24; WT 18:34; AFN 10:56, where termed "irregular in numbers and occasional in this region"); with just a single post-1960 sighting prior to 2003 (02 Dec. 1994, AP). Since 2003, up to seven birds have wintered at BFM (Cooper 2005a, pers. obs.).

Common Merganser *Mergus merganser.* Extirpated as a winter resident; two modern records: 16 Jan. 1998 (B. Elliot); and two females on 26 Jan. 2000 (RB). Considered a "moderately common" winter visitor by von Bloeker (1943), this species now winters on large inland reservoirs in the region (Garrett and Dunn 1981) but was historically more common on the immediate coast (Willett 1933, Grinnell and Miller 1944).

Ruddy Duck *Oxyura jamaicensis.* Extirpated, then reestablished as a breeder; now a fairly common breeding resident. Between the 1950s, when common in winter (e.g., 53 along Ballona Cr. on 31 Dec. 1954, WT 21:34) and the construction of BFM in 2003, recorded in single digits during fall and winter, with peaks in late winter (Feb./Mar.) during the 1990s (AP) possibly involving early spring migrants. Since 2003, up to 30 birds have wintered at BFM (Cooper 2005a), with numbers lowest in early fall. Though breeding was known from the historical Ballona Wetlands ("formerly nested in the salt marsh [also referable to brackish wetlands] and may still do so in small numbers," von Bloeker 1943), it had apparently ceased doing so by the second half of the 20th century, when birds were present in winter only. With the construction of BFM in 2003, breeding was reestablished (8 young observed on 24 June 2003; T.P. Ryan), with additional broods the following summers (Cooper 2004, Cooper 2005b).

California Quail *Callipepla californica.* Extirpated as a breeding resident; three recent records. Von Bloeker (1943) considered quail a "common resident of the meadow (= grassland habitat) and meadow slope of the dunes. Nests here between middle April and late June," and confirmed nesting as late as 1940. This population persisted into the 1970s (15 seen from the Culver Blvd. bridge over Ballona Cr. on 05 Jan. 1975; KLG), and Dock and Schreiber (1981) wrote of a "small covey observed regularly throughout the year on (the area of Ballona Wetlands south of Culver Blvd.), and recorded sporadically (north of Culver Blvd. and north of Ballona Cr.)." Post-1980s records limited to a "flock" on what is now Playa Vista on 22 August 1998 (RDS); one on the Westchester Bluffs on 10 Apr. 1999 (B. Elliot); and a male and a female at BFM 17–18 Apr. 2004 (C. Day, RB, m. ob.), the male continuing to 26 July (RB). Quail remain common in the Baldwin Hills just east of the Ballona Valley (Garrett 2001).

American Bittern *Botaurus lentiginosus.* Extirpated as a winter resident; two modern (post-1960) records. One apparently wintered at BFM 23 Oct. 2004–03 Apr. 2005 (RB, B.G. Johnson), and another was at the Ballona Wetlands on 06 Dec. 1980 (RSh). This species was once much more numerous in winter and migration at PdR (von Bloeker 1943), and one on the early date of 06 Aug. 1924 (Bird-Lore 26:347) suggests the possibility of nesting. Birds were recorded on the Los Angeles CBC through the early 1950s (Table 2), and the last local record during this period is of one at PdR 07–20 Jan. 1952 (WT 18:28).

Least Bittern *Ixobrychus exilis.* Extirpated, then reestablished as a rare and localized resident, essentially confined to BFM. The first modern record was of one present at BFM 24 July–05 Aug. 2003, and up to two have been recorded here year round since, including one heard singing at BFM through spring 2005 (Cooper 2005b). Historically, this species likely nested in the Ballona Valley; von Bloeker (1943) wrote "formerly rarely seen in late spring and summer in vicinity of tule-bordered ponds and sloughs in the salt marsh. As a result of the elimination of many of the tule patches (for agriculture, *Ibid*), this species may no longer occur. . ." Subsequent to that statement and before the 2003 record, the Least Bittern was recorded just once at Ballona: a probable transient at PdR on 07 Sept. 1950 (AFN 5:38).

Green Heron *Butorides virescens.* Extirpated, then reestablished as a breeder; now an uncommon resident. Up to 4 birds per day have been recorded year round since the 1990s, with nesting first confirmed in 1995 (fledglings at a condominium complex near Ballona Lagoon on 16 July 1995; LACBBA). Breeding was noted at BFM in 2005 (Cooper 2005b). Until the 1930s, the Green Heron was a characteristic breeding bird of Ballona: six egg sets were collected between 1933 and 1935 (WFVZ), and Howsley (1936) estimated four pairs nesting in the area. Between then and the 1990s, however, records were restricted to fall and winter (RSh, LACM files).

White-faced Ibis *Plegadis chihi.* Extirpated as a winter resident; now an uncommon fall transient (late Aug.–early Dec.), occasional in spring and early summer. In 2003, up to 20 were present more or less continuously from 20 July (3, RB) through early November (1 to 09 Nov., m. ob.), with similar numbers present in the following autumn (2004). There have been six records of apparent spring transients (12 Apr.–23 May) since 2003, mainly from BFM, as well as two recent June records. Only a handful of records were known between the 1940s and 2003, most involving fall migrants (incl. small flocks). Ibis were apparently regular in winter and spring through the 1920s (Bird-Lore 26:131; Bird-Lore 29:285), and Grinnell (1898:13) considered it "of common occurrence in fall, winter and spring," adding "a few remain through the summer in the Ballona marshes, and A.M. Shields believes that they breed here." By mid-century, it was irregular in winter (von Bloeker 1943), the last instances of over-wintering coming in the early 1940s (Bird-Lore 45:15; NAS 2002).

Turkey Vulture *Cathartes aura.* Extirpated as a winter resident; now an uncommon transient. Recent (post-1990s) records have been concentrated in spring and mid-fall (Sept.–Oct.), coinciding with the peak movement through southern California (Rowe and Gallion 1996). Though over-wintering is unknown, spring migration begins as early as late Dec., with early sightings typically occurring during periods of warm, southerly air flow. A handful of late spring and summer records (e.g., Westchester on 14 June 2003, RDS) likely involve tardy migrants or wanderers rather than local breeders. Birds were apparently more common through the winter in previous decades (e.g., six birds on 12 Dec. 1981, RSh) and von Bloeker (1943) considered the Turkey Vulture a "common resident." It later grew scarce, with AP recording just a handful in the 1990s, mostly in May and October.

Northern Harrier *Circus cyaneus.* Extirpated as a breeding resident; now an occasional fall and winter visitor (Oct.–Dec.). Harriers formerly occurred in winter in small but consistent numbers, but have not over-wintered here since the mid-1990s (AP, RDS). Up to two birds are recorded on the Los Angeles CBC each year (NAS 2002), and only one winter sighting per year at Ballona is now expected. A high of seven was on the Ballona Wetlands 01 Jan. 1955 (WT 21:34), and harriers nested at Ballona as late as 1953 (WFVZ; other egg records from 1935 and 1947).

Clapper Rail *Rallus longirostris.* Extirpated as a resident breeder. A resident population of the Light-footed Clapper Rail (*R. l. levipes*) persisted at least into the 1950s. Four were at PdR 09 Oct.–06 Nov. 1950 (AFN 4:35), and singles were recorded on the Los Angeles CBC in 1952, 1955, and 1956 (NAS 2002). This population had been long documented by specimen and egg collections (Grinnell 1898; WFVZ), with the last egg set collected 24 Apr. 1944 at "Del Rey" (WFVZ). In the past fifty years there have been but two records, presumably of vagrants from extant populations in neighboring Ventura or Orange counties, in "February" 1966, a calling bird at the Ballona Wetlands near the tidal inlets from Ballona Cr. (*fide* MSM); two in "January" 1995 in this same tidal channel (D. De Lange, pers. comm.; photos of one reviewed by KLG but subsequently lost).

Virginia Rail *R. limicola.* Extirpated as a resident breeder; reestablished as an uncommon transient and rare (or rarely-seen) winter visitor at BFM. Small numbers have been recorded here since 2003, with dates extending from 23 Aug. to 05 May (RB, KL). Von Bloeker (1943) considered the Virginia Rail "resident in the salt marsh" (but note his expanded definition of salt marsh, which included freshwater and brackish marshes), and breeding was documented in 1902 ("two egg sets taken by W.L. Chambers at Ballona, Los Angeles County, April 13, 1902." Willett 1933:32). The only other credible record from the 1900s was of one observed at PdR on 19 Feb. 1952 (WT 18:38). Several sightings in atypical habitat reported by Dock and Schreiber (1981) are not credible and may pertain to Common Snipe *Gallinago gallinago.*

Sora *Porzana carolina.* Extirpated as a breeding resident; reestablished as a fairly common transient and winter resident at BFM (July through May). The first modern record is of an early fall transient found mortally injured (possibly mobbed by crows or gulls) along Ballona Cr. on 29 Jul. 1998 (LACM 110576). All other recent records are from BFM since its opening in 2003 (five at BFM on 04 Jan. 2004), beginning with another fall transient on 31 July 2003 (RB). Von Bloeker (1943) considered the Sora "present in small numbers throughout the year in the salt marsh most frequently being found in vicinity of tule-bordered ponds and creeks," and even breeding (in "April and May"). Prior to the 1998 record, the last records of Sora in the Ballona Valley were from the early 1950s (AFN 5:225; WT 18:38).

Common Moorhen *Gallinula chloropus.* Extirpated as a (presumably) breeding resident; reestablished as an uncommon transient and winter visitor at BFM. The first modern record involved a transient at BFM on 19 Apr. 2003 (DSC), with subsequent records of up to two birds every month of the year (though no evidence of breeding or paired birds). This freshwater marsh obligate was apparently lost very early, for it was "seen frequently in a restricted area of the marsh" during April and May 1924 (Bird-Lore 26:278), with multiple birds present that fall (Bird-Lore 26:426). These two references comprise the entire historical record of this species at Ballona prior to 2003; its loss was apparently overlooked by von Bloeker (1943).

American Coot *Fulica americana.* Extirpated, then reestablished as a breeder; now a common breeding resident at BFM; still a transient and winter resident elsewhere. Prior to the construction of BFM, coots were mainly winter visitors to freshwater portions of Ballona Cr. (upstream of Culver Blvd.) and on Del Rey Lagoon (peaks of >200 birds Sept.–Mar.; RSh). Breeding was noted at BFM its first year (T.P. Ryan) and in subsequent years (Cooper 2004, 2005b). Though von Bloeker (1943) found this species breeding from mid-April to mid-June, it had apparently ceased doing so by the time the area was surveyed by Dock and Schreiber (1981) and Corey (1992).

Pacific Golden-Plover *Pluvialis fulva.* Extirpated as a fall transient and winter resident. The Ballona Wetlands, including the saltpan and the modern Ballona Cr. channel, were the last Los Angeles County wintering area for this species (records 14 Sept.–09 Mar.), with nearly annual records (up to 6 birds) through 1983 dating back at least to the 1920s (Bicknell 1924, WT, AFN, LACM files).

Snowy Plover *Charadris alexandrinus.* Extirpated as a breeding resident; now an occasional transient and rare winter visitor. Playa del Rey was historically an important wintering area (e.g., "more than 100 returned for winter at upper beach at Playa del Rey" in late July 1926; Bird-Lore 28:355), and several dozen birds were recorded on Los Angeles CBC into the 1960s (Table 2). Numbers declined sharply in the late 1960s, but Page et al. (1986) still found up to eight birds on eight of nine winter counts in the Playa del Rey area 1978–1985. By the end of the 1980s, birds were no longer wintering at Ballona (*fide* RSh, AP), and there have been only two winter records since the start of near-daily coverage by birders in early 2003, both of small flocks: just south of the Ballona Cr. mouth on 09

Jan. 2003 (10, KLG), and north of the Marina del Rey mouth 16–29 Dec. 2004 (up to 14, DB). Just to the south, a loose wintering flock has developed on Dockweiler State Beach since the 1990s (*fide* RB). Snowy Plovers historically bred on the sand spit that once separated the "Ballona swamp" from the ocean (Chambers 1904; Willett 1912), and though the last local egg set was collected on 18 June 1914 by J.E. Law (WFVZ), small numbers nested successfully as late as 1925 (Bird-Lore 27:273).

Black-necked Stilt *Himantopus mexicanus.* Extirpated as a breeder; reestablished as a common perennial resident and localized breeder away from the immediate coast. Stilts are found year round in freshwater portions of Ballona Cr. at low tide, at seasonal ponds on Playa Vista, and at BFM. They nested at least once on the Ballona Wetlands proper in recent years: an occupied nest that produced four young was found on 25 June 1998 (LACBBA). At BFM, a pair bred subsequently at BFM in 2003 (T.P. Ryan) but not since, but up to two pairs bred on nearby Playa Vista property (seasonal pools) in May 2004 (DSC). Historically, the Black-necked Stilt was much more common as a breeder, nesting noted through 1952 (AFN 6:299). Eight egg sets were collected on 11 May 1931 by L.R. Howsley, described in his journals (WFVZ) as being "3/4 mi east of Del Rey Hills Calif. (near Venice). Location in swamp area between main highway and the Del Rey Hills to the west. A colony of 9 or 10 nests here. Nest placed on top of salicornia [sic] so dense as to form a mat over a wide area and then died out leaving suitable 'platforms' upon which to build nests—only an inch or two above the water." During the latter half of the 1900s, however, the stilt occurred primarily as a transient and winter visitor.

American Avocet *Recurvirostra americana.* Extirpated as a breeding resident; now an occasional transient. Since the mid-1980s, there have been about 10 records, mostly in late fall (26 Sept.–01 Dec.), but also in spring (02 Mar.–27 May). Historically, the American Avocet was apparently resident, breeding at "Del Rey" in 1923 (Willett 1933). An egg set from this colony, noted as being "on mud-hump in marsh" was collected on 29 Apr. 1923 (WFVZ), and adults accompanied by young were present here the next year on 27 July (Bird-Lore 26:347), making the last year of known nesting 1924 (*contra* Willett 1933). Numbers of fall migrants would build through late summer (Bird-Lore 29:438; WT 16:8), and winter counts of up to 200 birds were recorded into the late 1950s (Bird-Lore 26:131; WT 13:28; NAS 2002). The avocet apparently declined through the 1960s (NAS 2002); RSh (1977–1987) recorded birds mainly in single-digits in winter and migration, including highs of 20 birds in January and February. The last Los Angeles CBC record was in 1993 (NAS 2002), and the only winter record in the past ten years (10 Feb. 1996, AP) may have been a very early spring transient.

Long-billed Curlew *Numenius americanus.* Extirpated as a winter resident; now an occasional transient. Spring dates extend from 08 Mar. to 31 May, and fall records are between 03 July and 17 Oct. (nearly all involving single birds). During visits in the 1970s and 1980s, RSh recorded it just six times 27 August–04 Apr., with a record of 5 birds on 06 Dec. 1980 being the last known winter sighting for the Ballona Valley. Historically a common transient and winter resident (von Bloeker 1943, Bird-Lore 26:278, Bird-Lore 26:347), curlews were recorded in small numbers on most Los Angeles CBC (presumably at Ballona) through the mid-1970s, reaching double-digits as late as 1958 (NAS 2002).

Burrowing Owl *Athene cunicularia.* Extirpated as a breeding resident; now a rare transient in fall and winter. Birds are apparently still attempting to winter locally, as singles have appeared along lower Ballona Cr. in three consecutive recent winters, though none remained for the entire season: 14 Jan. 2003 (B. Elliot), 15–16 Dec. 2003 (RB) and 27 Nov. 2004 through late Dec. (L. Brown, DB, m. ob.). Recent records of presumed migrants include one on the Westchester Bluffs "near the LMU sign" in April 1990 (Corey 1992); one found dead in PdR on 03 Mar. 2003 (LACM 112292); and birds credibly reported by locals along lower Ballona Cr. to DSC on 31 Oct. 2003 (2) and to J.R. Coffin in "late August" 2004. Von Bloeker (1943) found this species to be a "common resident of the dunes, meadow, and drier portions of the salt marsh," recognizing two distinct areas of nesting: in grassland and dune vegetation, birds lived in old burrows of California Ground Squirrels *Spermophilus beecheyi*; and in what were likely old housing pads at the western edge of current-day Los Angeles International Airport, he found them "in cavities excavated under the pavement." From 1977 to 1985, RSh recorded this owl on 11 out of 62 monthly visits (spanning the year) along Ballona Cr., on the Ballona Wetlands proper, and on the "Hughes Property" (now Playa Vista). Owls were recorded on Los Angeles CBC through the mid-1980s but on only two counts in past two decades (NAS 2002). Dock and Schreiber (1981) wrote of two pairs known nesting "in banks adjacent to Ballona Cr." and of birds "probably" nesting along bluffs south of the "agricultural area" (= Westchester Bluffs). The last known breeding occurred along Ballona Cr. in 1983 ("family of 4 birds" on 12 Mar. and 10 Oct.; RSh, B. Elliot).

Short-eared Owl *Asio flammeus.* Extirpated as a winter resident; now a casual transient. Historically observed using both the Ballona Wetlands proper as well as the grassland of the "Hughes property" (now Playa Vista). Both early (Bird-Lore 25:137; 30:137) and recent records indicate consistent wintering or attempts to winter, with sightings of up to three birds in fourteen winters between 1947 and 1996 (AFN, WT; *contra* Keane Biological Consulting 1996). The Short-eared Owl was consistently recorded on the Los Angeles CBC through the 1970s but the species has only been seen on one count since 1980 (NAS 2002). Since the last winter sighting (14 Feb. 1996, BOC), only two records of transients: Ballona Wetlands on 26 Oct. 2000 (BOC), and BFM on 20 Mar. 2004 (J. Fuhrman). Though there is no direct evidence of historical nesting, one was observed at "the Motordrome" (= Ballona Wetlands, near present-day BFM) on the late date of 11 May 1935 (field notes of L.B. Howsley, WFVZ).

Northern Flicker *Colaptes auratus.* Extirpated as a breeder; now a common fall and early spring transient; fairly common through winter. Though modern records extend only from 23 Sept. to early Apr., this species apparently once bred in the area, having been described by von Bloeker (1943) as nesting "in willows or in telegraph poles, and in corners under eaves of old houses." Early authors (e.g., Willett 1933) confirmed that this species was a common nesting resident in the lowlands of southern California.

Loggerhead Shrike *Lanius ludovicianus.* Extirpated as a breeder; now an uncommon summer, fall, and winter resident (June–March). Long a characteristic resident of the Ballona Valley (e.g., von Bloeker 1943), the last locally nesting shrikes were recorded at the Ballona Wetlands in the mid-1990s, with an occupied nest on 29 Apr. 1995 and "two young fledglings" observed on 09 June 1996

(LACBBA). Aggression or courtship displays were observed at the eastern end of the Playa Vista property on 14 June 1998 (LACBBA), and one was there in "April" 2000 (RDS), but no breeding evidence was obtained. An exceptionally early adult accompanied by a juvenile was present for one day near BFM on 16 May 2004, but was not seen afterward (J.R. Coffin).

Hutton's Vireo *Vireo huttoni.* Extirpated as a winter resident. Von Bloeker (1943) considered this species an "occasional winter visitant in the brushy portion of the sand dunes and in the willow thickets of the Playa del Rey salt marsh. Also found in shrubbery and trees around houses." He mentioned a specimen collected "on the meadow slope of the dunes" on 05 Dec. 1931, but aside from this, there is no other record of the Hutton's Vireo occurring at Ballona before or since, and no records from the Baldwin Hills (Garrett 2001). However, this species was probably at least a winter resident along Ballona Cr. before it was channelized, consistent with the species' general status in the Los Angeles Basin when riparian habitat was more extensive there (see Grinnell 1898).

Horned Lark *Eremophila alpestris.* Extirpated as a breeding resident; now a casual fall transient. A flock of five over BFM on 14 Nov. 2004 (KL, RB) provided the first record since fall 1994, when this species was recorded on 10 Oct. and 15 Nov. (AP, KLG). Once a characteristic resident of coastal dunes and fields in the Ballona Valley (e.g., 25 at the "Venice Marshes" on 29 Jan. 1955; WT 22:41), the last suggestion of local breeding came in the mid-1970s (one "skylarking" on 21 Mar. 1975, KLG). Birds were consistently recorded on the Los Angeles CBC until the late 1970s (e.g., *145* in 1975), after which just one bird has been found on a single count (NAS 2002).

Rock Wren *Salpinctes obsoletus.* Extirpated as a breeding resident; now a casual fall and winter visitor. Only about one per decade is now expected; recent records include singles on 13 Sept. 1980 (RSh), "winter c. 1992–1993" (KL), and "late Oct." 2001 (RSh). Von Bloeker (1943) wrote that this wren was a "resident of the established fore-dune area at El Segundo and along cliffs at Palisades del Rey" where they may have persisted until these bluffs were covered with houses in the 1960s and 70s.

Marsh Wren *Cistothorus palustris.* Extirpated as a breeder; now a fairly common fall transient and winter resident. The first fall arrivals appear in late August (23 Aug. 2003, RB), and birds are gone by the end of March. Von Bloeker (1943) considered the Marsh Wren a breeder "in tule patches, along edges of ponds and sloughs from April to June;" egg sets extend to 1936 (10 May at Venice, WFVZ).

Yellow-breasted Chat *Icteria virens.* Extirpated as a breeder; now an occasional transient. This species has been detected a handful of times both in fall (23 Sept.–09 Oct.) and in spring (15 Apr.–11 May), but local nesting, presumably in once-common willow thickets, is known only from a set of three eggs collected by J.H. Baumgardt on 20 May 1936 at "Venice" (WFVZ).

"Large-billed" Savannah Sparrow. *Passerculus sandwichensis rostratus* Extirpated as a winter resident; currently represented by one (rarely two) birds in winter. After decades of absence, the first modern record since the 1950s was furnished by a bird on the jetty at PdR from 09 Dec. 1998 to 27 Feb. 1999 (KLG), and it has been record nearly annually since, arriving as early as 15 August (in 2000, RB). Von Bloeker (1943) termed it a "common winter visitant in the salt marsh and along the seaward slope of the dunes," citing two specimens from 26 Oct. 1939. One early account mentions "numbers of Large-billed Sparrows all over jetties" on 05 Feb. 1947 (WT 13:28), and up to six individuals were recorded on the Los Angeles CBC until the mid-1950s (Table 2).

Black-headed Grosbeak *Pheucticus melanocephalus.* Extirpated as a breeder; now a fairly common transient; rare summer resident. Recent spring records extend into June, and fall birds have been seen as early as 05 August. Hamilton (1997) believed a male was on territory in willows at the base of the Westchester bluffs in summer of 1996, but subsequent searches here (by DSC and KL) have not revealed more records and no modern nesting evidence is known. Of this common southern California nester, von Bloeker wrote (1943) "moderately common summer resident in willow bottoms of the salt marsh and along Ballona Creek. Nests chiefly in May."

American Goldfinch *Carduelis tristis.* Extirpated as a breeder; now an irregularly uncommon transient and winter visitor. There is no evidence that this bird breeds locally, although recent (2004 and 2005) records during April and May include apparent pairs, singing males, and immature birds along the eastern edge of the Ballona Wetlands and in residential Westchester. Von Bloeker (1943) termed this species a "common resident, nesting in the willows of the salt marsh and along Ballona Creek chiefly in May and June." Numerous egg sets were collected in willows in the Ballona Valley during April and May from 1934 to 1936 (WFVZ).

Yellow-headed Blackbird *Xanthocephalus xanthocephalus.* Extirpated as a winter resident; now a fairly common spring and rare fall transient at BFM. Since the creation of BFM (2003), this species has proven regular in mid-spring, occurring from early April to mid-May, with even large flocks occasionally present (200–300 birds on 23 Apr. 2004; DS, DSC). Though rare in fall (three records in Aug.–Sept. since 2003), it was apparently historically common at this season, even remaining through winter (e.g., "50 seen at their winter haunts in the marsh area" on 28 Sept. 1925; Bird-Lore 27:417). Through most of the 1900s, the species was known as rare transient with just six spring records and one in fall.

New Colonists (see Above for Discussion of Cinnamon Teal)

Gadwall *Anas strepera.* Colonized as a winter resident; now fairly common in winter and migration on freshwater, including rain pools; uncommon through the summer; one recent breeding record. Up to 20 birds were present at BFM during its first winter (2003–04), and several apparently paired birds remained through the summer of 2003, eventually breeding in 2005 (two pairs, incl. an adult with 4 chicks on 16 June, RB). Not mentioned by von Bloeker (1943) or earlier authors, this duck was apparently a casual winter and spring transient in the Ballona Valley during most of the 1900s (three records 1950–1990s), with wintering noted only in 1998, presumably along Ballona Cr. (AP). The Gadwall has been expanding its breeding range in southern California and in northwestern Baja California, Mexico, most dramatically in the coastal lagoons of San Diego Co. (Unitt 2004).

Mallard *Anas platyrhynchos.* Colonized as a breeder; now a common breeding resident at BFM. Though its status may be obscured by the presence of feral birds, this duck was only an "occasional winter visitor" in the early 1900s (von Bloeker 1943), was absent on lower Ballona Cr./DRL from mid-Apr. to early

Sept. from 1977 to 1987 (BSh), and was unrecorded in summer by Corey (1992). Surveys since 1996 at Ballona Lagoon have found up to 10 on May–July visits (CLA), and Mallards were summering along Ballona Cr. by 1998 (AP). Successful nesting was documented on the Ballona Wetlands as early as 1995 (adult with three young on 18 April, LACBBA) and several pairs have raised young at BFM each year since 2003 (Cooper 2004, 2005b).

Ring-necked Duck *Aythya collaris.* Colonized as a winter resident; uncommon at BFM through winter. A single (?) bird at PdR on 07 Dec. 1995 (AP) served as the sole local record until the creation of BFM in 2003, when up to two pairs were present during the first winter (from 03 Oct. 2003, JP) and the subsequent year (Cooper 2005a). This species was unrecorded by von Bloeker (1943), so its historical status locally is unclear. However, given its preference for relatively deep freshwater ponds and tendency to avoid the immediate coast in southern California, it appears to be a recent addition to the Ballona avifauna.

Pied-billed Grebe *Podilymbus podiceps.* Colonized as a breeder; now a common and conspicuous breeding resident at BFM; fairly common fall transient and winter visitor in fresh and brackish water throughout. The first local nesting evidence came in 2003 and continued in subsequent summers (4 broods at BFM on 29 June, DSC; Cooper 2004, 2005b). Though the Pied-billed Grebe may have bred at Ballona historically, it was rare in summer in southern California during the early 1900s (Willett 1912, 1933), and was known only as a migrant and winter visitor here prior to 2003.

Great Blue Heron *Ardea herodias.* Colonized as a breeder; now a common breeding resident, most numerous in fall but localized in early spring when actively breeding. Small numbers nested in the lone cottonwood on the western edge of the Ballona Wetlands at least in 1995 (Keane Biological Consulting 1996; BOC), but now breed in trees at Marina del Rey adjacent to Ballona Cr. (e.g., 10 nests on 16 Feb. 2002, KLG; at least 8 nests in March 2004, DSC). This heron's historical breeding status is unknown, but it was only a transient and winter visitor by the 1920s (e.g., Bird-Lore 26:347). Von Bloeker (1943) found this heron "frequently observed in the meadow area and in the salt marsh" but did not mention breeding, and nor did subsequent authors (e.g., Dock and Schreiber 1981; Corey 1992).

Black-crowned Night-Heron *Nycticorax nycticorax.* Colonized as a breeder; now a fairly common breeding resident. Nesting was first documented in a row of eucalyptus at the "Oxford Basin" along Washington Blvd. in Marina del Rey (3 nests, 1 with young, on 11 April 1995; LACBBA). This site is still occupied (20 nests on 04 Mar. 2005, DSC). Historically an uncommon perennial visitor; previous workers (e.g., von Bloeker 1943, Dock and Schreiber 1981, Corey 1992) found small numbers year round (increasing through the 1990s, *per* AP), but with no indication of local breeding.

Merlin *Falco columbarius.* Colonized as a winter resident; now uncommon in migration and winter throughout the Ballona Valley and adjacent residential areas. Wintering dates since 1999 (*fide* RDS) have spanned 18 Sept. (2004, DSC) to 26 Apr. (2002, KL). Historically more frequently observed in inland areas in the Los Angeles Basin (Grinnell 1898, Willett 1933), I located only four Ballona records prior to 1997.

Elegant Tern *Sterna elegans.* Colonized as a summer resident; now common in spring, summer and fall along the immediate coast. Elegant Terns roost on the saltpan of the Ballona Wetlands and on the sandy beach in spring and summer, but are otherwise rarely seen away from salt water. Until the early 1980s, this tern was principally a post-breeding visitor to Ballona (30 Jul.–13 Nov.). However, spring records increased in frequency through the 1990s, possibly the result of a regional increase in nesting birds (Collins et al. 1991). Current high counts include several hundred birds in spring (400–500 on 28 Apr. 2005, B.G. Johnson.) and early fall (300 on 05 Aug. 2004, DSC). The first known local records of this tern came with a flock of "upwards of 300 birds" between 30 July and 28 August 1927 at PdR (Schneider 1927), but the species remained rare enough to be notable through the first half of the 20th century (von Bloeker 1943, Small 1950, WT 18:4).

Spotted Dove *Streptopelia chinensis.* Colonized as a breeding resident; currently rare and local, nearing extirpation. This non-native species was established widely in Los Angeles by the 1920s (Willett 1933), but was first reported locally by Dock and Schreiber (1981). Common and numerous into the 1990s (W. Sakai, RDS, AP), only sporadic sightings are now made, primarily in ornamental plantings near Ballona Lagoon. The last known local breeding was documented in Marina del Rey along Washington Blvd. on 24 Apr. 1999 (LACBBA).

Rose-ringed Parakeet *Psittacula krameri.* Colonized as a breeding resident; currently rare and local. This non-native species apparently arrived as a breeder during the 1990s, with a high count of 12 along Ballona Cr. at Beethoven St. on 18 Nov. 1995 (DS). One was excavating a cavity at a known nest site in PdR on 01 Feb. 1992 (KLG), which a pair then used for several years (M. Ingalls). Small numbers have since been present in PdR, mainly along Pershing Dr. (DSC).

White-throated Swift *Aeronautes saxatalis.* Colonized as a breeder; currently an irregularly common winter visitor (up to 100 birds Nov.–Feb.), less common during other times of year. Formerly present only in winter (e.g., von Bloeker 1943; RSh), nesting swifts apparently colonized as nesters in the late 1990s (confirmed 1997, LACBBA), with birds occupying "weep-holes" on the underside of State Route 90, which was constructed in the late 1960s.

Allen's Hummingbird *Selasphorus sasin.* Colonized as a breeding resident. Long known only as a migrant (von Bloeker 1943), breeding records date back to two nests found in Marina del Rey 22 and 24 May 1980 (Garrett and Dunn 1981). One bird remained through the winter in 1980–81 (unusual at the time), and breeding was again confirmed (female on nest) on 18 Dec. 1985 (J. Johnson, LACM files). Since then, it has become very common, occurring year round.

Cassin's Kingbird *Tyrannus vociferans.* Colonized as a breeding resident; now uncommon year round mainly in eastern Ballona Valley; occasional migrant along immediate coast. The first Ballona Valley sighting was made at PdR on 13 Apr. 1995 (AP), and local breeding was first noted in 2002 along Jefferson Blvd. Since then, nesting has been observed in Mar Vista and near Loyola Marymount University (KL, L.M. Fimiani).

Tree Swallow *Tachycineta bicolor.* Colonized as a breeder; now a fairly common transient, an uncommon winter visitor, and a local nester. Prior to the construction of BFM, this species occurred as a rare (or at least rarely-identified) spring transient, recorded on a handful of dates from 07 Feb. to 16 May. Since 2003, up to 100 have been observed at BFM during the peak of spring migration (February–Apr.), with lower numbers in fall (20 on 28 Nov. 2004, DSC) and small numbers remaining through the winter. In May 2004, a pair colonized one of several new nest boxes put up earlier that year at BFM, fledging at least two young in June (RB). Nesting commenced in early April the following year, with young again produced in June (Cooper 2005b). Widely extirpated as a breeder in southern California during the late 1900s, this species has reestablished itself locally south to San Diego Co., often utilizing bird boxes (Unitt 2004).

Northern Rough-winged Swallow *Stelgidopteryx serripennis.* Colonized as a breeder; now a common spring transient and a fairly common summer resident and early fall transient. Breeding was first noted in 1995 (LACBBA) with birds occupying essentially the same cement bridge habitat as White-throated Swifts (see above). Considered "occasional" in migration by von Bloeker (1943) and found just once by Dock and Schreiber (1981), RSh noted several into late April during the early 1980s, and Corey (1992) observed two in both May and June, suggesting that local breeding commenced before the 1990s.

Western Scrub-Jay *Aphelocoma californica.* Colonized as a breeding resident; now fairly common throughout the Ballona Valley except on the immediate coast. This jay was apparently not present during the 1930s (von Bloeker 1943) and was recorded by RSh (1977–87) just three times in dozens of visits to PdR. Multiple jays were observed at the Ballona Wetlands at least as early as 1990 (Corey 1992), when breeding was confirmed along the Westchester Bluffs. BOC found them every month of the year at the western Ballona Wetlands by 2002 (and in subsequent years), but they remain scarce along the immediate coast in Marina del Rey (*fide* DB); the first record from Ballona Lagoon was not until 26 June 2004 (CLA).

American Crow *Corvus brachyrhynchos.* Colonized as a breeder; now a common breeding resident. The crow was termed a "moderately common resident, not known to breed in the region" by von Bloeker (1943) and was recorded just singly on a few occasions by Dock and Schreiber (1981). Breeding was confirmed in the late 1990s (LACBBA) but may have began decades prior.

European Starling *Sturnus vulgaris.* Colonized as a breeding resident. Starlings are most numerous in summer and fall, when huge flocks of mainly first-year birds are recorded (e.g., 800 at the Ballona Wetlands on 03 July 2004, with 500+ continuing into August, DSC). Unrecorded by von Bloeker (1943), the first records of this introduced species in southern California were in the late 1940s, and it began an exponential increase in Los Angeles during the 1960s (Table 2), when it presumably became common in the Ballona Valley.

Brown-headed Cowbird *Molothrus ater.* Colonized as a breeder; now uncommon in migration and through summer; rare in winter. Though breeding was suspected in the Ballona area (location unknown) on 17 July 1995 (copulation observed, LACBBA), it was not confirmed until 2004 when a juvenile was observed being fed by Common Yellowthroats at BFM on 04 July (DSC). Only four credible records prior to the 1990s, all transients in spring and fall (first: 2 on 28 May 1976, KLG). One was purportedly collected by von Bloeker in February 1932, but on a day on which he reported collecting several questionable birds (e.g., Wrentit and Western Bluebird, both otherwise unknown from Ballona), possibly the result of a labeling error.

Great-tailed Grackle *Quiscalus mexicanus.* Colonized as a breeding resident. The first local record of this species was of a pair in flight over Westchester on

27 Apr. 1997 (RDS). The next came on 09 Apr. 2002 (BOC), but the grackle "invaded" Ballona in spring 2003, with nesting commencing that summer (42 birds at BFM on 30 July 2003, J. Pickus). This species is oddly scarce during August and September, suggesting a fall dispersal of local breeders out of the Ballona Valley.

Hooded Oriole *Icterus cucullatus.* Colonized as a breeder; now fairly common through spring and early summer (06 March–31 August). Nesting was suspected during the late 1990s (LACBBA), but was confirmed only in 2004 (J.R. Coffin) in a eucalyptus along lower Ballona Cr. Von Bloeker (1943) considered this oriole only a transient, and subsequent observers (Corey 1992; CLA; RSh, AP) recorded only a handful through the 1990s, all in spring.

Orange Bishop *Euplectes franciscanus.* Colonized as a breeder; currently fairly common March through November within a small area that includes BFM and the base of the Westchester Bluffs immediately to the south; occasional elsewhere in the Ballona Valley and in winter. The total population in the Ballona Valley may not exceed 20 individuals and appears to be confined to invasive pampasgrass *Cortederia sellona.* The first local record came in 1997 with one at the base of the Westchester Bluffs (RDS). Other early records include birds at the western Ballona Wetlands on 23 Oct. 2000 (6, R.A. Erickson) and 10 Oct. 2002 (BOC). The first record at BFM came on 01 June 2003 (3, DSC), and displaying males and hatch-year birds have been observed since then.

Data-deficient Taxa—Historical Presence at Ballona Questionable

Snow Goose *Chen caerulescens.* Modern records are now limited to about one per decade, the most recent in December 2001 at Del Rey Lagoon and adjacent Ballona Cr. (KL). Apparently unusual by the early 1900s (Bailey 1915), Grinnell (1898) described flocks feeding in the "Centinela grain fields" and roosting at sea, but did not provide a specific location.

Black Rail *Laterallus jamaicensis.* Though von Bloeker (1943) considered this species a "rare resident," he noted "there appear to be no recent records of the occurrence of this rail in this locality." Only two known records: 16 May 1895 (Grinnell 1898) and 25 Feb. 1928 (Ewan 1928).

Sandhill Crane *Grus canadensis.* Cranes historically occurred (pre-1900) in winter throughout the Los Angeles Basin (see Grinnell 1898) but were considered rare by the 1930s (von Bloeker 1943), with the only known Ballona record involving a bird at the Recreation Gun Club (east of PdR) from 25 Jan. to 27 Feb. 1949 (WT 15:28).

Mountain Plover *Charadris montanus.* This species was recorded on the Hughes airstrip (now Playa Vista) on 03 Dec. 1972 (J. Brandt); along Ballona Cr. on 30 Oct. 1976 (WT 43:6); and at PdR (2) on 02 Nov. 1979 (WT 46:8), but not before or since.

Greater Roadrunner *Geococcyx californianus.* Von Bloeker (1943) considered it a "resident of the meadow (= grassy areas inland from the saltmarsh and dunes) and sand dunes. Nests in April and May, usually in patches of cactus (*Opuntia littoralis*)," but this may have pertained to the El Segundo Dunes to the south; only one record is specifically known from the Ballona Valley, a male at PdR on 29 Dec. 1908 (LACM 21866).

Long-eared Owl *Asio otus.* Just two confirmed records: a "roadkill" (*per* von

Bloeker 1943) at PdR on 31 Dec. 1929 (LACM 16842) and another specimen from Marina del Rey on 08 Jan. 1934 (LACM 87423). Dock and Schreiber's (1981) remarkable report of 1–2 Long-eared Owls "flushed out of trees" just north of Ballona Cr. in "October" 1980 was given without details and may not be credible given the species' rarity at that time (Garrett and Dunn 1981). This owl was more common historically, even breeding in the Los Angeles Basin in the early 1900s (WFVZ).

California Gnatcatcher *Polioptila californica.* One historical record: 07 Oct. 1888 (LACM 12790) from "Port Ballona," a record evidently overlooked by von Bloeker (1943). The historical status of this species in the Ballona region is unclear; there is no conclusive evidence of its ever occurring north of Redondo Beach along the coast, nor in the nearby Baldwin Hills, despite the presence of Rufous-crowned Sparrows, Cactus Wrens and other coastal scrub species there (Garrett 2001).

Wrentit *Chamaea fasciata.* Von Bloeker (1943) considered Wrentit a "resident of the brush-covered portions of the dunes and meadow," noting breeding in April and May. Though he cited a specimen "collected on the meadow [= inland] slope of the dunes 13 Feb. 1932," this is the only known reference to this species' occurrence in the Ballona region (no egg records or specimens have been located), and it occurred on a date on which von Bloeker collected several unusual specimens (see above). Common in the Santa Monica Mtns., the Wrentit is unknown from the much more extensive scrub habitat of the Baldwin Hills and from the Palos Verdes Peninsula, but historically occurred in dense riparian thickets elsewhere on the floor of the Los Angeles Basin (Garrett and Dunn 1981; Garrett 2001).

California Thrasher *Toxostoma redivivum.* Two sightings in 2002: one on 08 June on the Westchester Bluffs (RDS) and another at the western edge of the Ballona Wetlands (at a seed feeder) in "October" (BOC). Von Bloeker (1943) considered the California Thrasher a fall and winter visitor, citing one caught in a rat trap on 25 Oct. 1931 (specimen not located), but this may have referred to the more extensive scrub of the El Segundo Dunes to the south. This sedentary species is casual in the nearby Baldwin Hills (Garrett 2001) and on the Palos Verdes Peninsula (*fide* KL), though a common resident to the north in the Santa Monica Mtns.

Sage Sparrow *Amphispiza belli.* No specific Ballona Valley records, although historically, the Bell's Sage Sparrow (*A. b. belli*) may have been a post-breeding visitor to the El Segundo Dunes: birds were collected at "Hyperion" on 16 July 1917 (LACM 1967); and at "El Segundo" on 08 Jan. 1925 (MVZ 81542) and 22 Aug. 1931 (von Bloeker 1943). Field notes of P.H. Robertson (WFVZ) mention "a few" Bell's Sparrows in dunes at "Redondo" on 16 June 1899.

Acknowledgments

This work would not have been possible without the enthusiastic cooperation of numerous individuals, especially the local birders who have sent me sightings and updates since 2003. I am especially grateful to Chuck and Lillian Almdale, Barbara O. Courtois, Jean Pickus, Robert Shanman and Russell and Dorothy Stone for granting permission to mine their long-term databases of bird sightings from the Ballona region. Herb Clarke graciously lent me several historical photographs of the pre-Marina del Rey Ballona Wetlands and related helpful first-hand information about this vanished landscape. Edith Read of the Center for Natural Lands Management facilitated this effort in numerous ways, and Kimball L. Garrett accommodated many visits to conduct research at the Natural History Museum of Los Angeles County. Linnea Hall and Rene Corado of the Western Foundation for Vertebrate Zoology and Carla Cicero of the Museum of Vertebrate Zoology, University of California welcomed me at their institutions.

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Accepted for publication 13 February 2006.

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105(3), 2006, pp. 113–127

The Role of Increased Sea Surface Temperature on Eelgrass Leaf Dynamics: Onset of El Niño as a Proxy for Global Climate Change in San Quintín Bay, Baja California

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Abstract.—We present a quantitative study of the effects of sea surface temperatures on eelgrass productivity variables. We compared standing stock variables for *Zostera marina* for the strong El Niño event of 1986–1987, previously published by other workers for San Quintín Bay, Baja California, to our previously unpublished data for the "normal year" of 1992–1993. We found significant differences for most of the variables measured, which included Leaf Area Index, leaf length, width, dry weight and area, biomass, shoot density, and number of leaves per shoot. Inspection of the multivariate ENSO index (MEI) and sea surface temperature (SST) anomalies for each of these years showed that the differences could be explained by the warm SSTs associated with the ENSO event. We were able to explain the observed differences from a dynamic perspective by using a leaf-growth model forced by SSTs. We conclude that sea surface temperature summarizes the fundamental environmental influences on eelgrass leaf dynamics observed in our study site. That is, higher SSTs explain the reduction in mean leaf lengths and the corresponding diminution in related productivity variables. This study also strengthens the view that the onset of an El Niño event provides anticipatory evidence for the effects that a rise in global temperature is expected to elicit in eelgrass beds.

Human-induced increases in atmospheric concentrations of greenhouse gases are expected to exacerbate global temperature change (Ramanathan 1988). The associated alterations could be particularly deleterious for estuaries and coral reefs, currently under noticeable anthropogenic stress. These relatively shallow environments will be affected through alterations in abiotic variables like temperature and sea level, wind patterns and storminess, availability of precipitation water and runoff, and modifications in availability of nutrients (Dyer 1985; Emanuel 1987; Wigley and Raper 1987; Bakum 1990; Peterson *et al.* 1993; Watson et al 1996; Kennedy et al. 2002).

Sea-surface temperature has been found to have a great influence in marine ecosystem dynamics (Tegner and Dayton 1987; Baumgartner *et al.* 1992; Beer and Koch, 1996; Holbrook et al. 1997; Johnson et al. 2003). In particular, warmer temperatures are expected to influence the biology of organisms by reducing the concentration of dissolved oxygen in seawater. Diurnal and annual temperature oscillations also influence the biology and distribution of aquatic angiosperms (Holmes & Klein, 1987). Several workers have reported that growth dynamics of the temperate seagrass *Zostera marina* L. is highly correlated with sea surface temperature (Short an Neckles 1999; Solana-Arellano *et al.* 1997, Poumian-Tapia & Ibarra-Obando 1999; Solana-Arellano et al. 2004). According to Setchel (1929) eelgrass can grow only within a fixed temperature range. Other authors (Rasmussen 1977; Phillips and Backman 1983) have also shown that temperature is fundamentally important in controlling the seasonal growth cycle of eelgrass.

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The distribution and abundance of seagrasses in temperate littoral waters are also controlled by light availability (Backman and Barilotti 1976; Denninson and Alberte 1985; Bulthuis and Woelkerling 1983; Orth and Moore 1988; Zimmerman *et al* 1991). In particular, light has been shown to influence the distribution (Dennison & Alberte 1985), density (Mukai et al. 1980), flowering (Phillips & Backman 1983), biomass (Mukai et al. 1980) and production (Bulthuis 1987) of *Zostera marina.*

Dissolved oxygen, inorganic nutrients (including carbon) and water movements also modify photosynthesis in aquatic plants. While light, temperature and dissolved oxygen regulate instantaneous photosynthetic rates, the availability of inorganic nutrients affects the long-term response of photosynthesis by controlling the levels of photosynthetic enzymes and pigments (Solana-Arellano et al. 1997). Eelgrass can absorb nutrients either from the roots or the leaves (McRoy et al. 1972). Hence, modifications in upwelling activity, stratification, and tidal dynamics could alter the availability of dissolved nutrients and thus affect seagrass productivity. In our study area (San Quintin Bay, Baja California, one of the last remaining ecologically functional estuaries in the California Bight), the onset of an ENSO event alters sea surface levels and temperatures, as well as tidal dynamics and nutrient availability (Álvarez-Borrego 2004). Hence, it is reasonable to expect that ENSO-like conditions would influence eelgrass dynamics in the bay. Sea surface temperature provides a reasonable paradigm for an ENSO-like alteration. Since thermal expansion of the water column influences sea level variation (Wigley and Rapper 1987) sea level can be assumed to increase, thus modifying light availability and changing tidal dynamics and circulation (Short and Neckles 1999). Also, thermally induced stratification would imply a deeper thermocline and nutricline, and modify upwelling transport of dissolved nutrients (Petterson et al. 1993). Hence we would expect sea surface temperature to be a variable that triggers changes in the dynamics of the principal environmental influences on eelgrass in our study site.

To provide a basis for the assumption of significant causal linkage between an ENSO warming event and changes in the growth dynamics of eelgrass we demonstrate here that sea surface temperature accounts in a fundamental way for the observed variability of standing stock variables by comparing two whole-year-cycle data sets of *Z. marina* L. in the San Quintín Bay estuary. The first data set, for the ENSO event of 1987–1988, was previously published by Ibarra-Obando et al. (1997). The second data set was collected by our research group from November 1992 through November 1993. Both data sets consist of means for leaf length, width, dry weight and area, biomass and density per square meter, Leaf Area Index (LAI), and number of leaves per shoot.

Due to the architecture of Z. *marina*, above-ground productivity is determined by the dynamics of leaf elongation. To show that temperature controls productivity, we demonstrate a causal relationship between temperature and leaf length by using a leaf-growth model forced by sea surface temperature. We produced a consistent representation of leaf-length dynamics for both data sets and corroborated that sea surface temperature can be considered a fundamental environmental forcing agent for productivity variables of eelgrass at our study site. An alteration of the normal variation range for this variable like that registered during the onset of an ENSO event provides anticipatory evidence for the effects that an equivalent change in global temperature would elicit on eelgrass beds at our study site. This agrees with the view on this causal relationship for seasgrasses discussed in Short and Neckles (1999).

Study Site

San Quintin Bay is a Y-shaped shallow coastal lagoon on the Pacific side of the Baja California Peninsula, Mexico (30°30N–116°10′W), which has a total area of 42 km^2. Evaporation exceeds runoff plus precipitation. In the Bay's waters, tides are mixed and predominantly semidiurnal and are considered the main cause of temperature variability (Álvarez-Borrego 2004). Upwelling events bring nutrient-rich waters near the mouth of the bay (Dawson 1951) and tidal currents propagate those waters throughout the bay. To some extent, this accounts for the rather high nutrient content of its waters (Barnard 1962; Álvarez-Borrego and Álvarez-Borrego 1982). Organic matter is trapped and materials are re-mineralized, releasing nutrients back to the water column. These remineralization processes (Smith et al. 1991), along with turbulence induced by tidal currents and waves, control nutrient concentrations in the lagoon (Álvarez-Borrego 2004).

Sampling and Exploratory Analysis

The sampling site is a mudflat located in the west arm of the bay. We collected shoots monthly from sixteen 20 × 20 cm quadrats selected at random, from November 1992 through November 1993. Each sample was placed in individually labeled plastic bags and cooled until processed. Each shoot was cleaned with distilled water. We determined the number of shoots and leaves per unit area, the length (*mm*), width (*mm*) dry weight (*g*), and area (mm^2) of each leaf. A total of 10,000 complete leaves were collected through the entire year cycle. Biomass per unit area and L.A.I estimations are presented in $g\ m^{-2}$ and $m^2\ m^{-2}$ respectively. For both data sets that were analyzed, underwater radiation at 1 meter under sea level was measured (Em^{-2}) by using a PAR and direct beam quantum radiometer-photometer (Li-Cor, Inc.) using an integration time of 1000 s. The integrated photon flux rate in a time interval centered at noon gives a reasonable estimate of the maximum radiation in the day. Daily variation can then be approximated by the Monteith sine law (Monteith 1965). *In situ* temperatures for both data sets were also obtained (figure 5 b). Principal Component Analysis (PCA) was developed for all variables in both our data and that of Ibarra-Obando et al. (1997) to assess the importance of abiotic variables. Nutrient data are not available for 1992–1993 so we used upwelling index values as a proxy in accordance with

Álvarez-Borrego (2004) that reports upwelling as the main source of dissolved nutrient availability in the site.

Data in MEI values SST anomalies and Upwelling index were obtained from NOAA (http://www.cdc.noaa.gov.people.klauss.wolter/MEI/table.html, http://ferret.pmel.noaa.gov/NVODS/servlets/datasets and ftp://orpheus.pfge.noaa.gov/outgoing/upwell/monthly/upindex.mon). Data on sea level values at San Quintin Bay were provided by the Laboratorio de Nivel del mar, Departamento de Oceanografia Física CICESE (http://nivelmar.cicese.mx/).

Theoretical Methods

Following Nadezhda et al. (2001) we considered that water temperature, light radiation and nutrients are the fundamental environmental influences on eelgrass growth. In accordance with Álvarez-Borrego (2004) we will consider that the availability of dissolved nutrients is controlled by upwelling activity at our study site. We designate sea surface temperature by $T(t)$ at a time t. Similarly $\phi(t)$ means underwater light radiation and $U(t)$ are values of the upwelling index.

Let $l(t)$ denote eelgrass leaf length. Then, leaf length rate dynamics will be assumed to follow the growth model,

$$\frac{dl}{dt} = k(t)[l_\infty - l(t)], \tag{1}$$

where l_∞ is the maximum possible value that leaf length can be attain. This constant is also known as the asymptotic upper bound for leaf growth. For leaf length values that are very close to l_∞, vanishing leaf length rates are expected (Batschelet 1974). The scaling factor k(t) summarizes the fundamental environmental influences on leaf dynamics. It can be formally represented through the expression

$$k(t) = f(T(t), \phi(t), U(t)), \tag{2}$$

where $f(t)$, $\phi(t)$, $U(t)$ is assumed to be continuous and differentiable in all of its arguments. Increasing water temperatures are known to affect eelgrass metabolism and the maintenance of a positive carbon balance (Zimmerman *et al.* 1989). Optimum eelgrass photosynthesis is attained at temperatures below a seasonal maximum (Biebl and McRoy 1971). Temperatures above the growth optimum to near the upper limit of thermal tolerance have resulted in reduced eelgrass productivity (Thayer et al. 1984; Moore et al. 1996). This conceptual framework, along with the assumption that a change in $T(t)$ triggers a response in the remaining variables of equation (2) is consistent with the assumption that $k(t)$ can be represented in terms of mean sea surface temperature $T(t)$. The forcing factor $k(t)$ can be assumed to have the polynomial form

$$k(t) = \sum_{n=1}^{N} a_n T^n(t). \tag{3}$$

Integration of equation (1) from t_i to t_{i+1} led us to the equation,

$$\frac{l_\infty - l(t_{i+1})}{l_\infty - l(t_i)} = \exp\left[\int_{t_i}^{t_{i+1}} k(t)\, dt\right] \tag{4}$$

After a few algebraic steps equation (4) provides the regression expression,

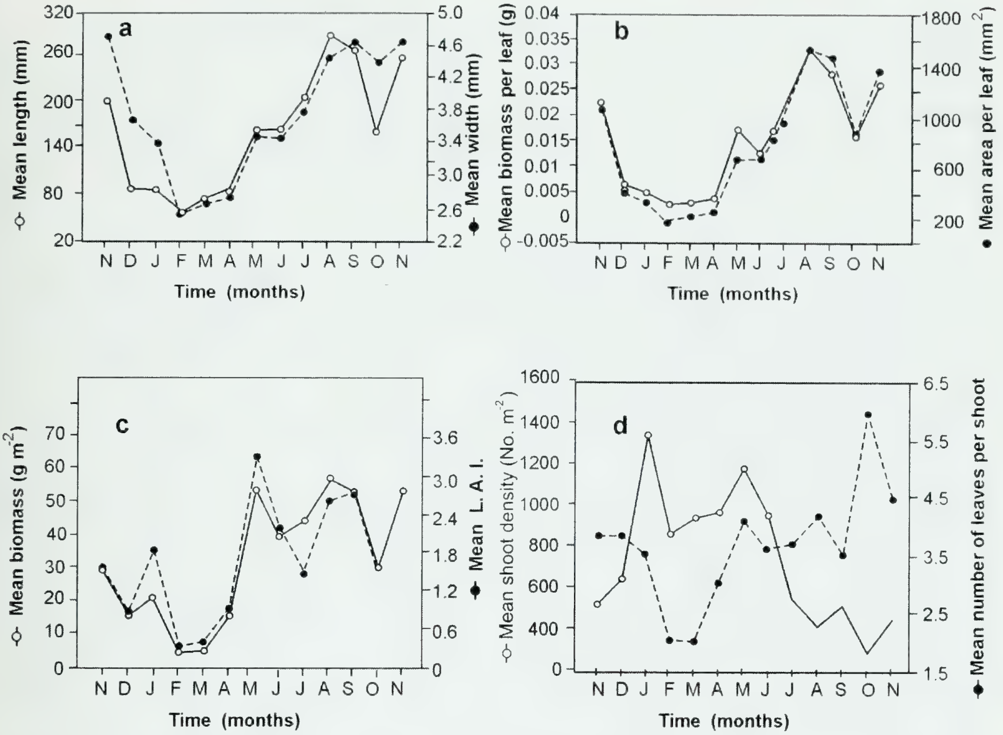

Fig. 1. Mean monthly values for *Zostera marina* standing stock variables and leaf area index (LAI) measured in San Quintin Bay during the "normal" year of 1992–1993.

$$l(t_{i+1}) = l_\infty - [l_\infty - l(t_i)]e^{G(t_i,t_{i+1})} \tag{5}$$

where by virtue of equation (3) $G(t_i, t_{i+1})$ has the form:

$$G(t_i, t_{i+1}) = -\sum_{j=1}^{N} a_i \int_{t_i}^{t_{i+1}} T^i(t)\, dt \tag{6}$$

In order to corroborate empirically the assumption of equation (3) we fitted equation (5) to available data on leaf length and sea surface temperature. Determination coefficients, graphs of predicted *vs* observed values and residual analyses are presented in the results section. The mean square regression method and the statistical package STATISTICA were used in these fittings.

Results

Maximum leaf width was 4.6 mm and occurred in November 1992, and maximum leaf length of 290 mm was reached in August 1993 (Fig 1). Leaf-widths close to maximum values also occurred in September and November 1993. Changes in mean leaf length and width followed the same variation pattern; the maximum for both measurements was attained by late summer (Fig. 1a). Similar results were obtained for mean leaf area and mean leaf biomass; both measurements reached their maximum in August, (Fig. 1b), these were 1543 m m^2 and 0.*034* g respectively. Biomass per unit area reached a maximum of 57.02 g m^{-2} in August, but another peak of 54.04 g m^{-2} occurred in May (Fig. 1c). This was

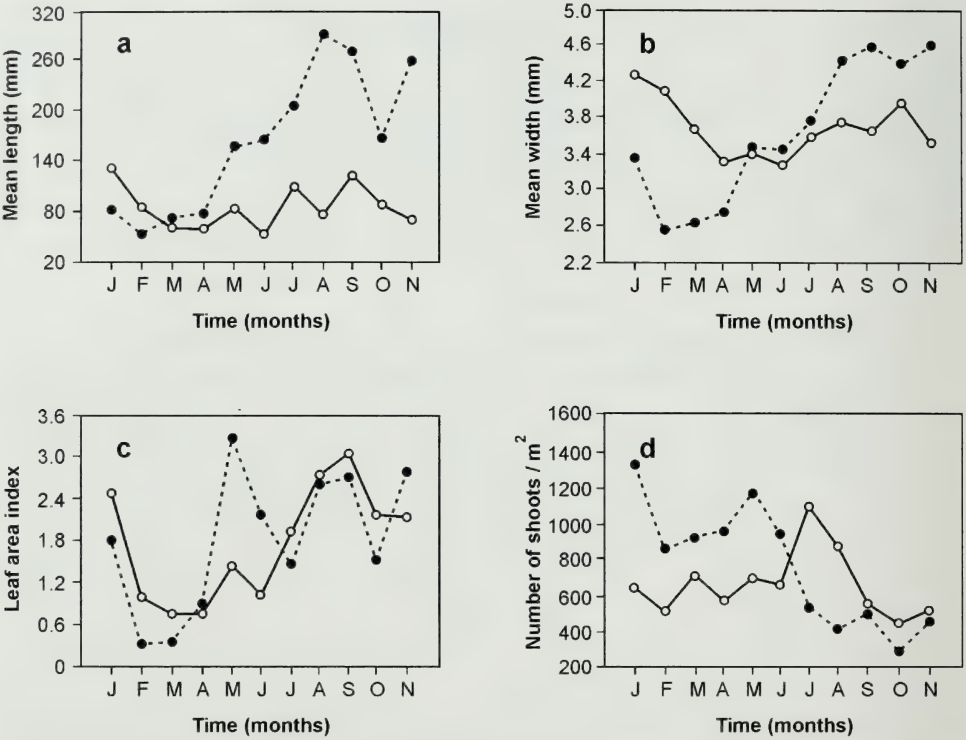

Fig. 2. Comparison of mean values for variables in our study with those of the 1986–1987 El Niño year reported by Ibarra-Obando et al. (1997) data at the same depth. Dashed lines corresponds to our study and continuous lines to Ibarra-Obando et al. (op. cit)

likely due to the period of reproduction, as a large number of reproductive shoots was observed at this time. Mean L.A.I had a maximum of 3.3 and was also attained in May. The inverse relationship between mean numbers of shoots and leaves is shown in Fig. 1d, such that minimum numbers of shoots (less than 400 shoots per square meter), occur when the number of leaves reaches its maximum of 6 leaves per shoot, and maximum number of shoots (1390 shoots m^2) is reached almost at the same time the average number of leaves per shoot is declining to its minimum (2 leaves per shoot). This relationship could be explained by the autoecology of seagrasses (Kentula and McIntire, 1986), since light decreases during winter, the plant uses its energy to produce fewer shoots with a large number of leaves so they have more access to light.

For the El Niño year of 1986–1987, Poumian-Tapia & Ibarra-Obando (1999) reported smaller values for mean length, biomass, number of shoots and number of leaves per shoot than the ones found in our study for the same area (Fig 2.). We fitted a general linear model for upwelling index values in terms of dissolved nitrates and phosphates and their cross products, finding a determination coefficient of $R^2 = 0.88$. All estimated parameters had *p-values* < *0.05* (*0.0090* for nitrates, *0.009* for phosphates and *0.03* for the cross product of nitrates and phosphates), meaning that the 3 terms contribute to the multiple correlation coefficient. This result also provides a quantitative basis for the linkage between dissolved nutrient concentration and upwelling index values.

A Principal Components Analysis (PCA) for the 1987 data extracted a first component defined mainly by temperature, with a correlation coefficient of $R = 0.95$ and irradiance with a correlation coefficient of $R = -0.74$. This component explained 39% of the variability of biotic variables. Second and a third components were represented by nitrates and phosphates in that order, with coefficients of correlation $R = 0.91$ and $R = -0.66$ which explained 29% and 20% of the variability, respectively.

For the 1992–1993 data we used upwelling index values as a proxy for dissolved nutrient availability. In that PCA, we found a first principal abiotic factor defined by temperature and irradiance with correlation coefficient of $R = 0.85$ for temperature and -0.68 for irradiance. This factor explained 41.4% of the variability of biotic variables. A second component was mainly defined by upwelling with $R = 0.74$ and this factor explains 33.2% of the variability of all variables.

PCA results for both years, which showed a dominant forcing of SST on eelgrass productivity variables, were corroborated by the fittings of equation (5). This fitting produced a high coefficient of determination ($R^2 = 0.94$) for the 1987 data and an $R^2 = 0.97$ for the corresponding 1992–1993 leaf length data. Analysis of residuals showed a good correspondence between eelgrass leaf length and sea surface temperature for both data sets. Figure 3 shows the corresponding predicted *versus* observed values associated for each fit. This demonstrates that the observed differences can be explained by higher temperatures. In other words, sea surface temperature is a variable that summarizes the fundamental environmental influences that determine leaf length dynamics, and therefore of other variables such as biomass and L.A.I for eelgrass in our study site.

Discussion

This work presents the most recent data for important variables used in eelgrass production studies in San Quintin Bay (fig. 1). The nearest related sampling in the area occurred in 1987–1988, as reported by Ibarra-Obando et al. (1997). They reported smaller values for mean leaf length and also for most of the productivity related variables than our present results (fig. 2). An analysis of the causal linkage between sea surface temperature, underwater light radiation, dissolved nutrient availability and eelgrass productivity variables leads us to conclude that a higher temperature is the most important factor determining the observed differences. Our findings sustain the paradigm that a warm temperature stress can induce a deleterious effect in *Z. marina,* (Rasmusen, 1977, Penhale, 1977; Wetzel and Penhale, 1983; Evans et. al. 1986; Johnson et al. 2003).

Primary and secondary production in the California Current (CC) are high when the transport of the cool, low-salinity water from the north is strong and low when this transport is weak (McGowan 1983). Periods of warming and low productivity in the CC tend to coincide with El Nino events in the eastern tropical pacific. ENSO events induce warming of SSTs in San Quintin Bay (Silva-Cota and Alvarez-Borrego, 1988). The present analysis shows that slower growth rates in *Z. marina* reported by Ibarra-Obando et al. (1997) could be a consequence of the ENSO event that took place from June 1986 to January 1988, just before and during the year where their data were taken Comparison of MEI and SST values demonstrates clear differences between the 1987 ENSO and the "normal" conditions of 1993 (Fig 4.).

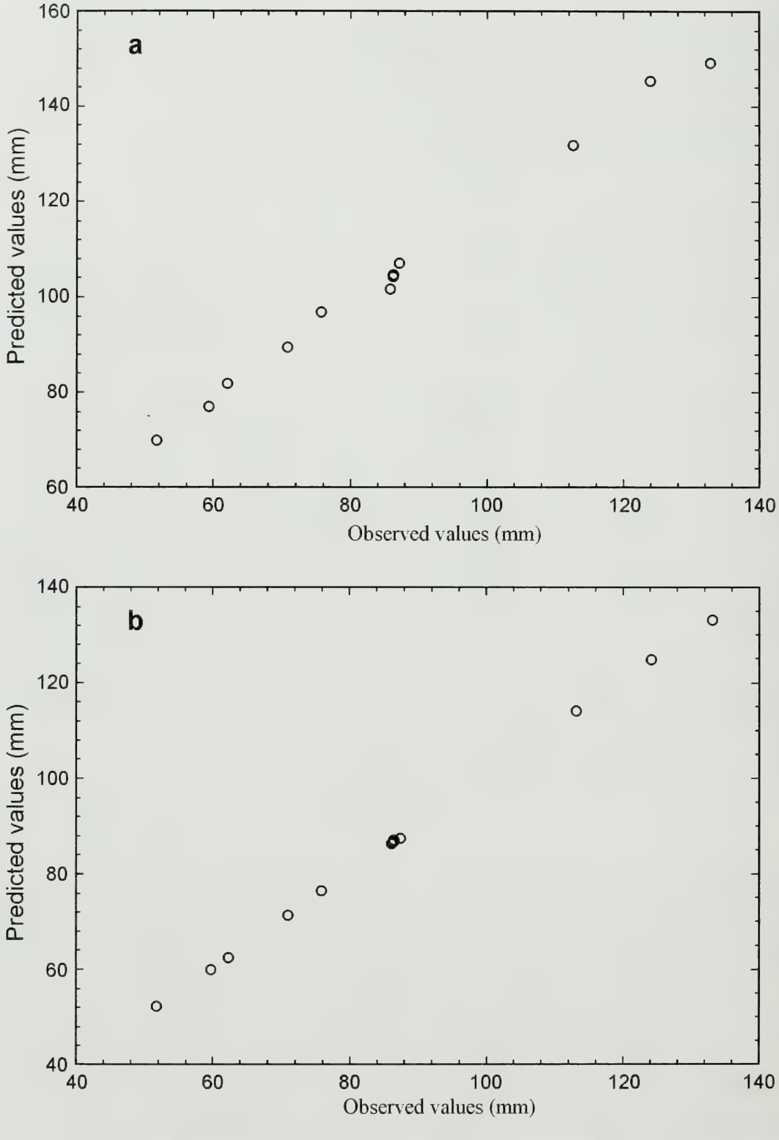

Fig. 3. Observed versus predicted values for the fitting of equation (5) to mean length data. a) Fitting corresponding to the Ibarra-Obando et al. (1997) data. b) Fitting corresponding to our data.

Thermal expansion of sea water results in higher sea level values (Wigley and Rapper 1987), which can reduce light reaching seagrass beds at depth and thus limit photosynthesis (Short and Neckles (1999)). For *Z. marina,* the effects of decreased light are reduction in shoot density, leaf width, number of leaves per shoot, growth rate (Short *et al.* 1993) and above-ground plant productivity (Backman and Barilotti 1976). Comparison of sea-level anomalies for San Quintín Bay, shows largely negative anomalies during the non-ENSO conditions of 1985 and positive anomalies during the 1987 ENSO (fig. 5). Thus we can infer that sea level anomalies were largely negative in 1993. There were also significant dif-

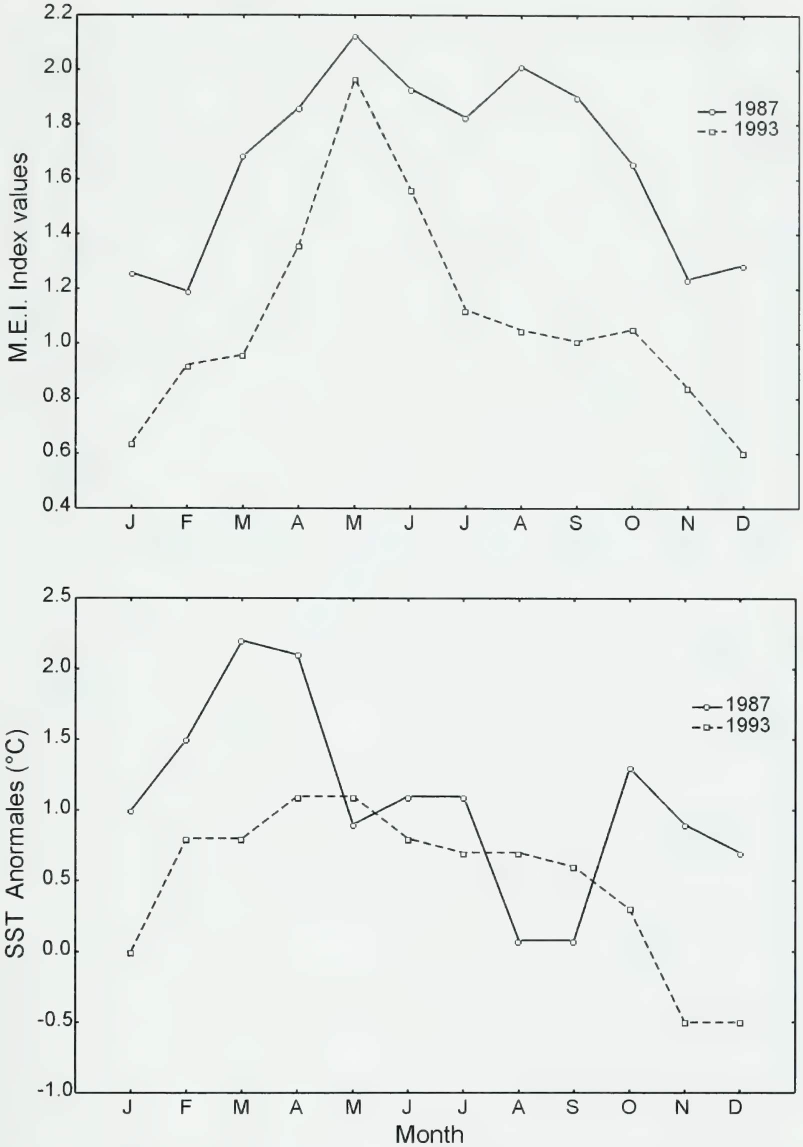

Fig. 4. Above) Multivariate Enso Index values for 1987 and 1993. Below) Corresponding Sea Surface Temperature anomalies.

ferences (p = 0.03) in mean light radiation between our 1993 data and those of Ibarra-Obando (1997). This occurred for both the incident light flux and underwater light availability (Fig 6). Temperature stress and reduced availability of light likely contributed to lower productivity of eelgrasss in 1987.

Upwelling of nutrient-rich waters during non-ENSO conditions maintains high nutrient levels in the water column. But thermal stratification can modify the depth of both the thermocline and the nutricline and so influence nutrient transport by upwelling. Upwelling index values are in a good correspondence with dissolved nutrient availability, corroborating reports on the role of an ENSO event in the reduction of dissolved nutrient availability in our study site (Silva-Cota and Ál-

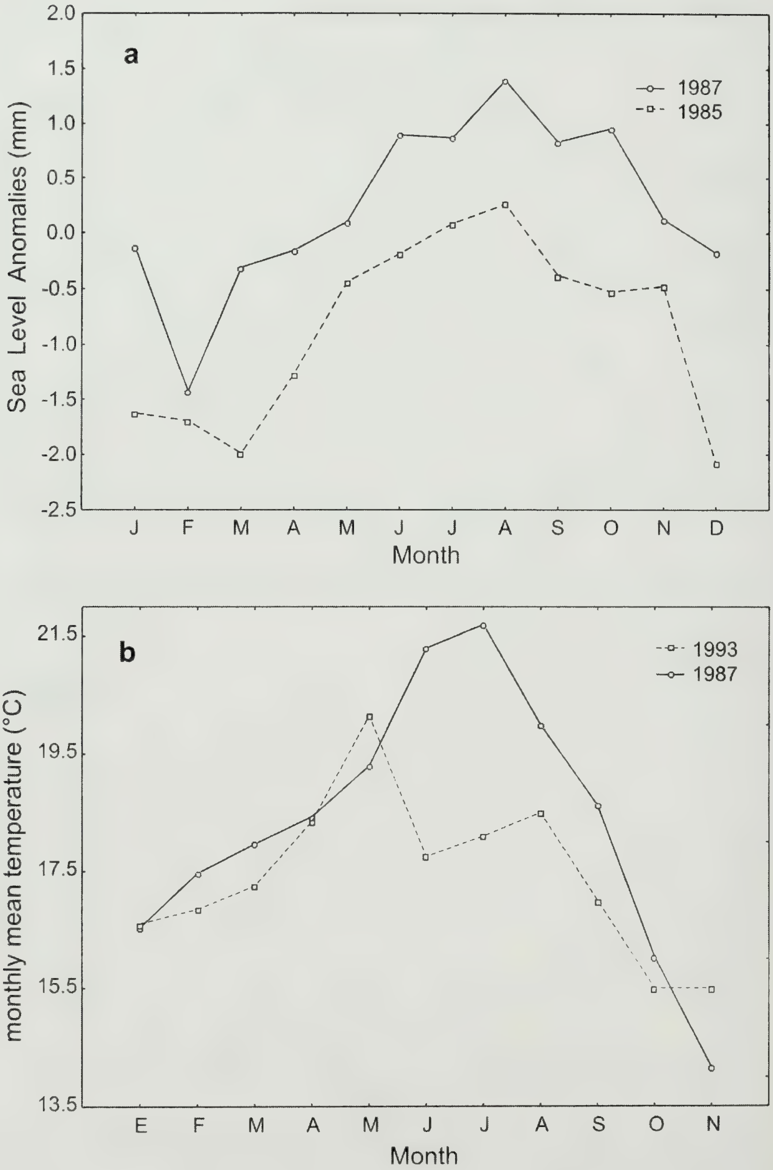

Fig. 5. a) Sea level anomalies for San Quintin Bay for the ENSO year of 1987 and 1985 a year before the onset of the referred ENSO event. Higher sea level values for the ENSO event year area observed. b) Mean monthly temperatures for Ibarra-Obando et al. (1997) and present study data sets at San Quintin Bay.

varez-Borrego, 1988). This strongly suggests an unfavorable influence for eelgrass productivity, in addition to temperature and light availability effects.

We conclude that for the 1987 data the conjunction of a high temperature stress, reductions in light radiation and availability of dissolved nutrients could explain the diminution in eelgrass productivity variables during the 18-month ENSO event. Ibarra-Obando et al. (1997) found a turnover time of about 38 days for *Z.*

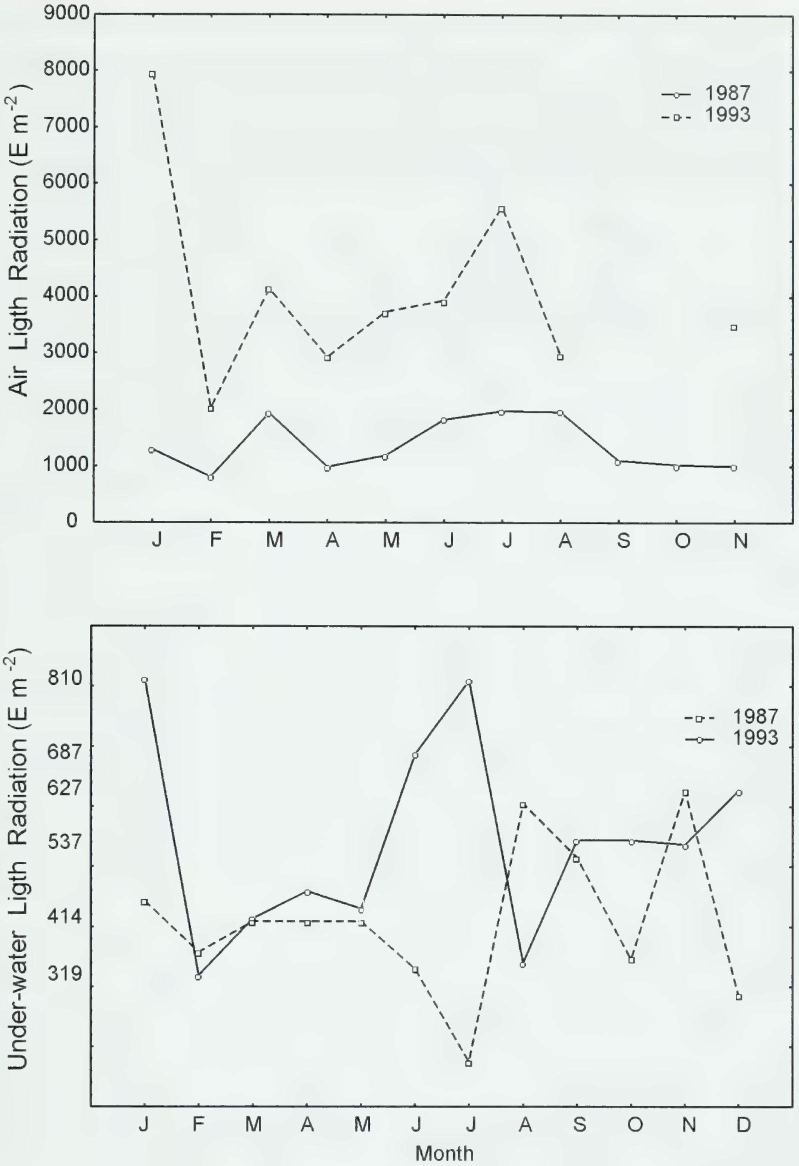

Fig. 6. Above) Incident Light Radiation in San Quintin Bay during the ENSO event year of 1987 and 1993 which was consider as normal. Below) Underwater light luminosity corresponding to the same years. We can notice a grater light availability for the 1993 sampling period.

marina L., in San Quintin Bay. Reduced turnover times could have shortened responses to environmental stress for these seagrass populations in such a way that the associated effects were observable during the reported year–cycle study. In any event, both the performed PCA and the fitting of equation (5) show that environmental influences which controlled the observed dynamics can be summarized in a reasonable way by sea surface temperature variability.

The present study provides the first quantitative framework for corroborating the assumption that an increased temperature, as observed on the onset of an El

Niño event, will elicit reduced growth rates in *Z. marina* (Fig. 3). ENSO driven alterations are limited to 12–18 months between periods of normal conditions that range from 2–7 years. A continued ENSO–like anomaly could result in long-term unfavorable temperature conditions, triggering changes in light radiation and in the availability of dissolved nutrients. Besides the abatement of productivity variables, this could also disrupt adaptive response in eelgrass and promote its replacement by subdominant species as reported by Johnson et al. 2003.

Global climate change is expected to result in modifications of SST, sea level, CO_2 concentrations and UV radiation reaching the Earth's surface (Houghton and Woodwell, 1989; Mitchell 1989; Schneider 1994; Kerr 1992; Watson et al. 1996; Titus 1990; Smith et al. 1992; Schellnhuber et al. 2006), and to induce severe effects on both terrestrial and aquatic plants (Watson et al. 1996). In particular, global change is likely to exacerbate the deleterious effects of human activities on estuaries and costal lagoons (Kennedy *et al.* 2002). The effects of anthropogenic activities on estuaries are well documented in the literature (Roblee et al., 1991; Walker and McComb 1992; Short and Willie-Echeverria 1996). On the other hand the mechanism underlying climatic change effects are poorly understood. The expected changes linked to global warming on submerged plant species like sea grass beds and salt marshes are of a great concern due to the important ecological services they provide and the current extent of their loss.

The present study indicates that the onset of an El Niño event alters the San Quintin Bay environment with changes in sea-surface temperature, level and underwater light radiation. Similar changes for these variables are expected to occur in a global change scenario. Even though ENSO events have also driven changes in dissolved nutrient availability at the site, it is more difficult to predict how global change will affect this factor. Upwelling caused by northerly winds and the resulting offshore Eakman transport is a dominant oceanographic process in spring and summer along the entire California and Baja California Coast (Sverdrup et al. 1942). Observations show that wind-driven upwelling along the California Current has increased over the past 30 years (Snyder et al. 1993). This increase is assumed to be elicited by temperature gradients induced by increasing greenhouse gas forcing, but such association has been speculative. In the event of a positive association of global climatic change and intensification of upwelling, it might be reasonable to expect that the observed non-limiting nutrient environment within San Quintin Bay could be maintained. But increased sea temperature in the waters adjacent to the mouth of the bay and a coupled stratification could promote a deepening of the thermocline and nutricline, rendering upwelled waters deficient in nutrients, regardless of how intense the transport might be (Petterson et al. 1993). This coincides with reports on a reduced dissolved nutrient availability in the waters adjacent to the mouth of San Quintin Bay during an ENSO event (Silva-Cota and Álvarez-Borrego 1988).

Our findings strentengthen the view that the onset of an El Niño event provides valuable anticipatory scientific evidence on the effects on eelgrass productivity variables as a consequence of a global climatic change (Schneider 1994), particularly those associated with sea surface temperature, and underwater light radiation. For dissolved nutrients, the onset of an El Niño event at our study site could reduce dissolved nutrient availability probably linked to a deficient upwelling transport.

Acknowledgments

This paper is part of the research on eelgrass production partially funded by the Mexican National Council on Science and Technology (CONACYT) through grant 26665-B. We acknowledge a great debt to Olga Flores-Uzeta and Cecilia Leal for their technical assistance. We also thank Jose Ma. Dominguéz and Francisco Ponce for the figures.

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Accepted for publication 26 June 2006.

Bull. Southern California Acad. Sci.
105(3), 2006, pp. 128–142

The Fish Assemblages Inside and Outside of a Temperate Marine Reserve in Southern California

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Abstract.—The purpose of this investigation was to evaluate the effect of a small marine reserve (established 1988) on a temperate rocky reef fish assemblage at Santa Catalina Island, California. Fish surveys on SCUBA were conducted at two reserve and two non-reserve sites from October 2002 to January 2004. Sites were similar in fish density, species richness and biomass of the entire fish assemblage. However, the adult densities of two important fishery species, California sheephead (*Semicossyphus pulcher*; 7.6 ± 0.5 and 5.5 ± 0.4/100 m^2 inside versus outside) and kelp bass (*Paralabrax clathratus*; 3.6 ± 0.4 and 2.9 ± 0.4 inside versus outside), were significantly higher within the reserve. The reserve appears to be effective in increasing density and biomass of two impacted species that were readily observed and surveyed on SCUBA.

Introduction

Fully protected marine reserves are a powerful tool for conservation and management prompted by declining fish stocks (Botsford 1997; Halpern and Warner 2002). Marine reserves have various functions, one of which is to prevent fishing and the removal of any living or nonliving marine resource (Lubchenco et al. 2003). Benefits of marine reserves for fish and invertebrate populations have been demonstrated previously in many studies, largely in tropical regions (Bell 1983; Alcala 1988; Bennett and Attwood 1991; Buxton and Smale 1989; Russ and Alcala 1989; McClanahan and Shafir 1990; Polunin and Roberts 1993; Grigg 1994; Jennings et al. 1994; McClanahan 1994; Watson and Ormand 1994; McClanahan and Kaunda-Arara 1996; Stoner and Ray 1996). The interest in no-take refuges has emerged, in part, because of the collapse of many fisheries worldwide and the failure of traditional fisheries management techniques to protect them. Marine reserves may influence ecosystems in many ways (Russ 2002). Theoretically, inside a marine reserve, 1) fishing mortality is reduced significantly, 2) densities of target species increase, 3) mean size/age and biomass of target species may increase significantly and 4) higher production of propagules of target species occur per unit area. Areas outside of the marine reserve may benefit both from the density-dependent spillover of adults into fished areas and in the net export of eggs/larvae from the marine reserve (Russ and Alcala 1996). The latter can lead to an enhanced supply of recruits to fished areas (Russ 2002). Despite the fact that marine reserve research has focused on tropical habitats (e.g., Craik

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1981; Russ 1985; Russ and Alcala 1996), marine reserves are becoming increasingly popular as management tools in California in response to declining fish stocks (Paddack and Estes 2000, Craig et al. 2004, Parnell et al. 2005, Parnell in press. However, relatively few studies have described the effects of marine reserves in California. This may be due, in part, to the fact that these reserves are few in number (Paddack and Estes 2000) and generally small in size (Lowe 2003; Parnell et al. 2005). Despite this lack of knowledge, there has been considerable interest in expanding marine reserves throughout California in an effort to enhance stocks of impacted species (Paddack and Estes 2000). The Marine Life Protection Act of 1999 mandates the establishment of a marine reserve network in California to promote the sustainability of marine resources and is currently being developed by the Department of California Fish and Game. Therefore, it is both ecologically and economically critical that we understand the role of marine reserves in structuring fish assemblages in southern California so that effective marine reserves can be developed to maximize fish production and minimize restricted habitat. In this study we examined some of these hypotheses in a temperate, island ecosystem in southern California.

It is perhaps most important to evaluate the effect of marine reserves on species that are most intensively targeted. In southern California, the kelp bass (*Paralabrax clathratus*) and the California sheephead (*Semicossyphus pulcher*) are prominent members of the southern California rocky reef fish assemblage and support substantial fisheries. Fishing pressure on kelp bass has increased over the last 50 years and has resulted in a decrease in landings in California (Rodgers-Bennett 1991, Allen & Hovey 2001). California sheephead are a protogynous hermaphrodite that have been historically targeted by recreational fishermen, both hook and line and using spear. However, since 1988 this species has also been targeted by the live-fin fishery and has accounted for nearly 90 % of all target species landed by this fishery since its inception in southern California (Palmer-Zwahlen et al. 1993). Kelp bass and California sheephead may serve as good indicators of the potential of marine reserves to enhance or restore fish stocks in California. Parnell et al. (2005) reported a significant increase in the proportion of large California sheephead males between the San Diego-La Jolla Ecological Reserve and comparable nearby habitats outside the protected area. Paddack and Estes (2000) studied three reserves in central California and found increased fish abundance and increased size of the heavily exploited rockfishes (Scorpaenidae) within two of the three reserves.

The fish stock enhancement potential of coastal reserves in California is promising. However, it is critical to enhance our understanding of this tool in the offshore California islands. The southern California islands consist largely of rocky shorelines while only 10–15% of the southern California mainland shoreline contains rocky substrate, effectively doubling the amount of hard bottom shoreline in California (Stephens et al. 2006). The southern California islands are likely less affected by anthropogenic influences including pollution and coastal runoff, although many are utilized intensively for recreational marine activities. These islands have also been the focus of a proposed reserve network to enhance fish stocks. The purpose of the present investigation was to evaluate the effect of a temperate marine reserve on the structure of fish assemblages on a southern Cal-

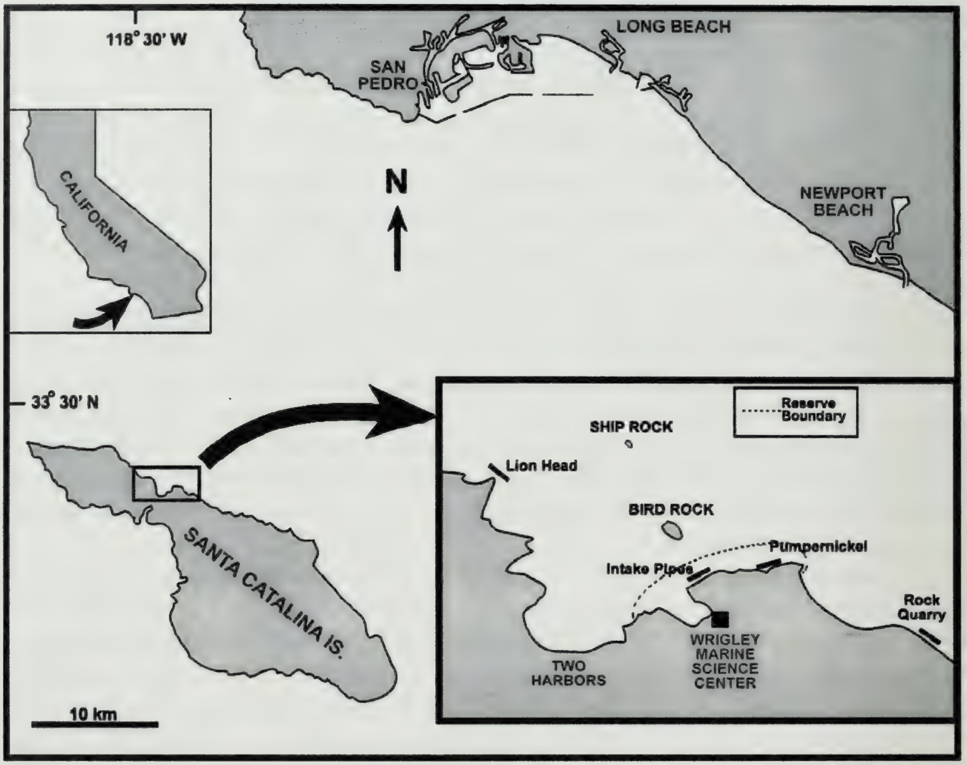
118° 30' W
LONG BEACH
SAN PEDRO
N
NEWPORT BEACH
CALIFORNIA
33° 30' N
SHIP ROCK
Reserve Boundary
Lion Head
BIRD ROCK
Intake Pipes
Pumpernickel
Rock Quarry
TWO HARBORS
WRIGLEY MARINE SCIENCE CENTER
SANTA CATALINA IS.
10 km

Fig. 1. Location of the study sites at Santa Catalina Island, California.

ifornia island near the isthmus at Santa Catalina Island, California, using SCUBA surveys.

Methods

Four sites located near Big Fisherman's cove on the leeward side of Santa Catalina Island, California were studied from October 2002 to January 2004 (Figure 1). The Catalina Marine Science Center State Marine Reserve was established in 1988 and encompasses approximately 0.06 nm^2, and 1.08 nm of shoreline. This no-take reserve was established primarily for research and is under control of the adjacent Wrigley Institute for Environmental Studies, University of Southern California. The marine reserve is well marked and enforced, while recreational fishers and divers heavily utilize areas adjacent to the reserve. Two sites were located within the boundaries of this marine reserve: Pumpernickel Cove (33°32.89′ N, 118°28.78′ W) and Intake Pipes (33°26.82′ N, 118°29.11′ W), and two sites were located outside just outside the reserve: Lion Head (33°22.18′ N, 118°30.03′ W) and Rock Quarry (33°26.55′ N, 118°28.33′ W). Preliminary dives were conducted along the leeward side of Santa Catalina Island to qualitatively determine suitable reference habitats that were similar to the reserve sites in terms of size, habitat and vertical relief. Sites consisted of high relief (> 1m) boulder and rock cobble habitat that supported giant kelp (*Macrocystis pyrifera*) between five and 20 meters.

Conspicuous fishes were surveyed quarterly at the study sites from October 2002 to January 2004 (Figure 1). Fishes were surveyed using visual transects on SCUBA at six m and 12 m isobaths. All transects were conducted between 1000 and 1400 hrs. On each sampling date, divers swam 2 m wide × 50 m long transects along shore counting all conspicuous fishes within the 100 m^2 area and assigning each fish to one of five age classes (adult, sub-adult, juvenile, young of year or recruit). Counts made by two divers were averaged for each transect. All fishes that passed divers from behind were omitted to avoid duplicate counts of an individual fish or fishes that might be attracted to divers (Terry and Stephens 1976; Stephens and Zerba 1981; Stephens et al. 1984; Froeschke et al. 2005).

Biomass of fishes were estimated by age classes defined by total length estimates. The midpoint of each size class was used to estimate biomass for each species, in each age class, using established length-weight regressions following the methods of Froeschke et al. (2005). For species that did not have well-established length-weight relationships, the average mass of the individuals from each age class was estimated from collections taken during nearshore gill-net monitoring off southern California (Ponedella and Allen 2000; L.G. Allen and D.J. Pondella unpublished data). Biomass of the scythe butterflyfish (*Chaetodon falcifer*) and kelp perch (*Brachyistius frenatus*) were estimated using length-weight regressions from closely related and similarly shaped species for which the relationship was known (*Chaetodon auriga* for scythe butterflyfish and *Cymatogaster aggregata* for kelp perch). Cryptic species that were observed on transects were estimated by taking the mean weight of that species collected at the non-reserve sites during this study.

Transcribed data were entered and checked twice prior to statistical analysis. All statistical analyses were performed using *Systat* 9.0 (Systat Software Inc., Richmond CA, USA). Variation in the density and biomass of fishes among locations and sampling dates (season) was investigated using two-way analysis of variance (ANOVA) with replication. As is common with most ecological data, transect data were non-normal and had unequal variances. Data were $\log_{10}(x+1)$ transformed, which restored normality and homoscedasticity to these data prior to statistical analyses being performed.

Results

A total of twenty-eight species were observed on the 130 transects conducted during this study (Table 1). Species richness was similar between reserve and non-reserve sites (n = 23). Density, frequency of occurrence, and relative abundance were calculated for sites inside and outside of the reserve (Table 2). While densities of species varied among sites, blacksmith (*Chromis punctipinnis*) was the most abundant species at every site. Blacksmith accounted for 60% of all individuals inside the reserve and 67% outside the reserve and were present during all sampling periods (Frequency of Occurrence > 90%; Table 2). Total fish density did not differ significantly between the two sites in the reserve or the two sites out of the reserve, thus data were pooled at reserve and non-reserve sites to test for reserve effects on fish abundance and biomass. Mean density of conspicuous fishes was 163.7 ± 17.0 (number/100 m^2 ± 1 S.E.) in the reserve and 204.0 ± 19.3 outside the reserve (Figure 2a). Overall, fish density did not differ significantly between reserve and non-reserve sites (ANOVA, $F_{1,128} = 1.97$; $P = 0.16$).

Table 1. The scientific and common names of fishes surveyed at Santa Catalina Island. Fishes were organized by orders and families.

Taxa	Common name
Lamniformes	
Carcharhinidae - requiem sharks	
Galeorhinus galeus (Jordan and Gilbert, 1883)	tope
Rajiformes	
Dasyatidae - stingrays	
Urobatis halleri (Cooper, 1863)	round stingray
Anguilliformes	
Muraenidae - morays	
Gymnothorax mordax (Ayres, 1859)	California moray
Scorpaeniformes	
Scorpaenidae - scorpionfishes	
Scorpaena guttata (Girard, 1854)	California scorpionfish
Sebastes atrovirens (Jordan and Gilbert, 1880)	kelp rockfish
Sebastes serranoides (Eigenmann and Eigenmann, 1890)	olive rockfish
Sebastes serriceps (Jordan and Gilbert, 1880)	treefish
Hexagrammidae - greenlings	
Oxylebius pictus (Girard, 1854)	painted greenling
Perciformes	
Serranidae - sea basses	
Paralabrax clathratus (Girard, 1854)	kelp bass
Malacanthidae - tilefishes	
Caulolatilus princeps (Jenyns, 1840)	ocean whitefish
Haemulidae - grunts	
Anisotremus davidsonii (Steindachner, 1876)	sargo
Sciaenidae - croakers	
Cheilotrema saturnum (Girard, 1858)	black croaker
Kyphosidae - sea chubs	
Girella nigricans (Ayres, 1860)	opaleye
Medialuna californiensis (Steindachner, 1876)	halfmoon
Chaetodontidae - butterflyfishes	
Chaetodon falcifer (Hubbs and Rechnitzer, 1958)	scythe butterflyfish
Embiotocidae - surfperches	
Brachyistius frenatus (Gill, 1862)	kelp perch
Embiotoca jacksoni (Agassiz, 1853)	black perch
Rhacochilus toxotes (Agassiz, 1854)	rubberlip seaperch
Rhacochilus vacca (Girard, 1855)	pile perch
Pomacentridae - damselfishes	
Chromis puntipinnis (Cooper, 1863)	blacksmith
Hypsopops rubicundus (Girard, 1854)	garibaldi
Labridae - wrasses	
Halichoeres semicinctus (Ayres, 1859)	rock wrasse
Oxyjulis californica (Gunther, 1861)	senorita
Semicossyphus pulcher (Ayres, 1854)	California sheephead
Clinidae - clinids	
Alloclinus holderi (Lauderback, 1907)	island kelpfish
Heterostichus rostratus (Girard, 1854)	giant kelpfish
Gobiidae - gobies	
Lythrypnus dalli (Gilbert, 1890)	bluebanded goby
Rhinogobiops nicholsii (Bean, 1882)	blackeye goby
Pleuronectiformes	
Pleuronectidae - righteye flounders	
Pleuronichthys coenosus (Girard, 1854)	C-O sole

Table 2. The mean density per 100 m^2 ± standard error (S.E.), frequency of occurrence (F.O.) and relative abundance for fishes inside and outside of the Catalina Marine Science Center State Marine Reserve at Santa Catalina Island, California from 2002-2004.

	Reserve				Non-Reserve			
Species	Mean	S.E.	F.O.	%	Mean	S.E.	F.O.	%
Alloclinus holderi	0.06	± 0.03	0.06	0.04				
Brachyistius frenatus	5.94	± 1.06	0.80	3.63	4.59	± 0.69	0.70	2.25
Caulolatilus princeps	0.03	± 0.02	0.03	0.02				
Chaetodon falcifer					0.13	± 0.07	0.08	0.06
Cheilotrema saturnum					0.03	± 0.03	0.02	0.02
Chromis punctipinnis	99.80	± 13.95	0.94	60.96	136.41	± 19.51	0.93	66.88
Embiotoca jacksoni	0.42	± 0.11	0.25	0.26	2.00	± 0.45	0.52	0.98
Galeorhinus galeus	0.09	± 0.06	0.03	0.05				
Girella nigricans	1.10	± 0.16	0.52	0.67	2.21	± 0.39	0.59	1.09
Gymnothorax mordax	0.01	± 0.01	0.01	0.01	0.02	± 0.02	0.02	0.01
Halichoeres semicintus	4.58	± 0.44	0.93	2.80	2.51	± 0.28	0.79	1.23
Heterostichus rostratus	0.12	± 0.04	0.12	0.07	0.05	± 0.03	0.05	0.02
Hypsopops rubicundus	4.51	± 0.33	0.91	2.75	6.07	± 0.34	1.00	2.97
Lythyrypnus dalli	13.51	± 1.85	0.86	8.25	18.18	± 2.31	0.97	8.91
Medialuna californiensis	1.41	± 0.94	0.28	0.86	0.92	± 0.25	0.34	0.45
Oxyjulis californica	12.22	± 3.28	0.78	7.46	7.56	± 2.85	0.61	3.71
Oxylebius pictus					0.03	± 0.02	0.03	0.02
Paralabrax clathratus	9.74	± 0.60	1.00	5.95	10.13	± 0.70	0.98	4.97
Pleuronichthys coenosus	0.01	± 0.01	0.01	0.01				
Rhacochilus toxotes	0.06	± 0.03	0.06	0.04	0.03	± 0.03	0.02	0.02
Rhacochilus vacca	0.01	± 0.01	0.01	0.01				
Rhinogobiops nicholsii	2.38	± 0.32	0.77	1.45	6.92	± 1.10	0.97	3.39
Scorpaena guttata	0.01	± 0.01	0.01	0.01	0.02	± 0.02	0.02	0.01
Sebastes atrovirens	0.04	0.03	0.03	0.03	0.16	± 0.06	0.13	0.08
Sebastes serranoides					0.02	± 0.02	0.02	0.01
Sebastes serriceps	0.10	± 0.04	0.09	0.06	0.49	± 0.11	0.34	0.24
Semicossyphus pulcher	7.57	± 0.47	0.99	4.62	5.46	± 0.39	0.97	2.68
Urobatis halleri					0.02	± 0.02	0.02	0.01

Mean biomass (kg/100 m^2 ± S.E.) was 15.9 ± 1.8 in the reserve and 13.0 ± 1.5 outside the reserve. Similarly, no significant difference in mean biomass of fishes between reserve and non-reserve sites was detected (ANOVA, $F_{1,128} = 0.01$; $P = 0.91$; Figure 2b). Biomass peaked in Fall 2003 following the recruitment of juveniles to the reef, although this trend was not as dramatic as the peak in density. Overall, blacksmith strongly influenced seasonal patterns of abundance and biomass. Blacksmith accounted for almost 40% of the total biomass outside the reserve and 23% inside the reserve, ranking first and second respectively. However, this species is a relatively small planktivore that is not targeted in any current fishery. Because the comparative abundance of these fish obscured the trends that were observed in larger, less abundant fishery species, blacksmith were removed from the analysis of biomass. This substantially altered biomass patterns, as total biomass density was higher inside the marine reserve when blacksmith were excluded from the analysis (ANOVA, $F_{1,128} = 7.1$; $P = 0.01$). Biomass peaked in Winter 2003 inside the reserve, however this was primarily attributed to the presence of several adult (> 1.8 m) tope (*Galeorhinus galeus*) aggregating inside the reserve during the Winter 2003 sampling period. Similarly, biomass peaked in the

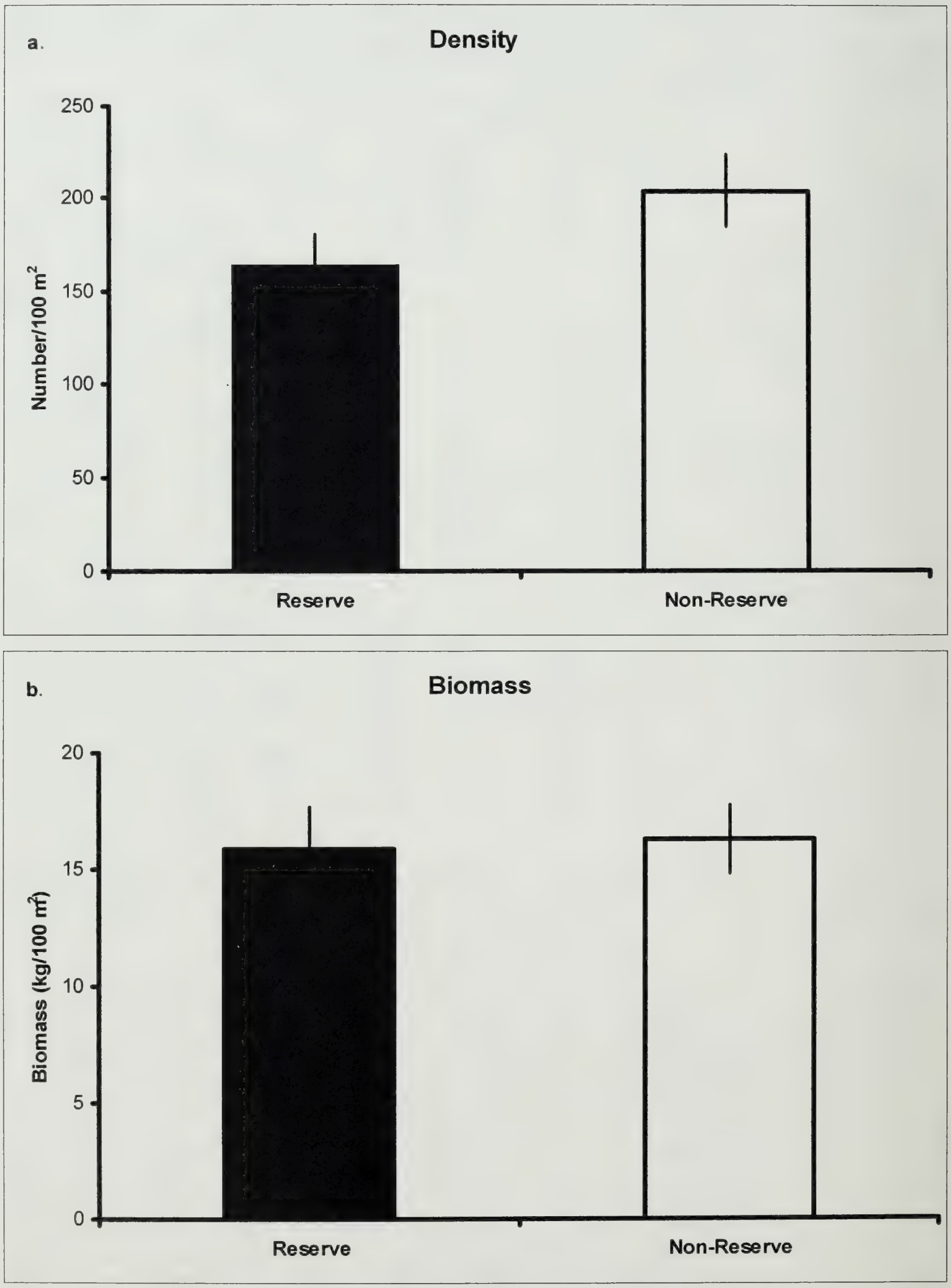

Fig. 2. a). Mean density of conspicuous fishes inside and outside of a marine reserve at Santa Catalina Island, California. There was no significant difference in mean density between reserve and non reserve stations (ANOVA, $F_{1,128} = 1.97$; $P = 0.16$). Reserve 163.7 ± 17.0 (n = 69), non-reserve 204.0 ± 19.3 (n = 61). b) Mean biomass of conspicuous fishes inside and outside of a marine reserve at Santa Catalina Island, California. There was no significant difference in mean biomass between reserve and non reserve stations (ANOVA, $F_{1,128} = 0.01$; $P = 0.91$). Mean biomass was 15.9 ± 1.8 (n = 69) in the reserve and 13 ±1.5 outside reserve (61).

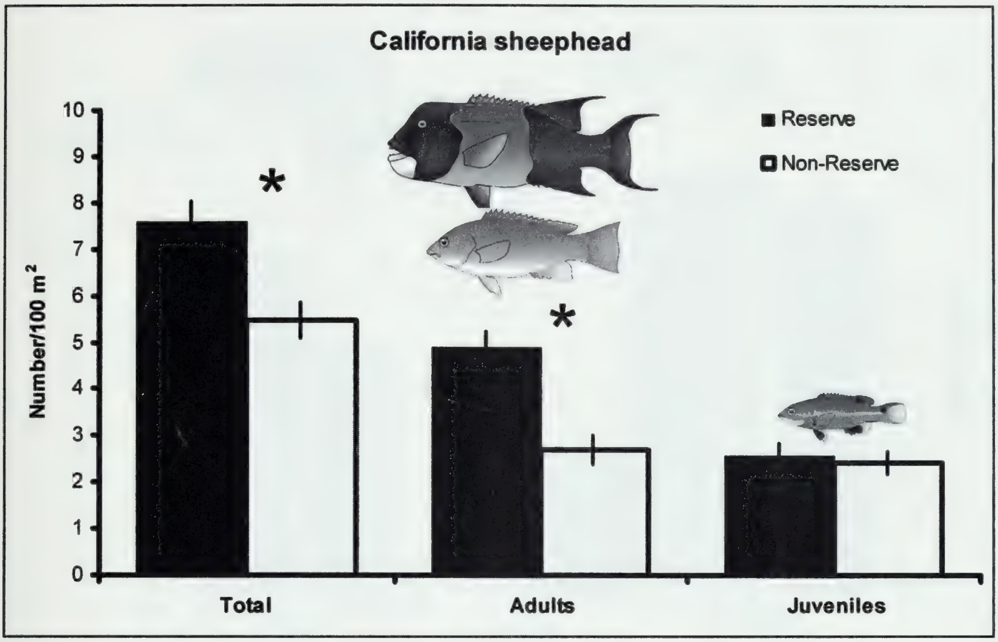

Fig. 3. Mean density of California sheephead inside and outside of a marine reserve at Santa Catalina Island, California. Total density was significantly higher within the marine reserve (Total ANOVA, $F_{1,128} = 9.8$; $P = 0.002$; Adults ANOVA, $F_{1,128} = 17.2$; $P < 0.001$). Density of juveniles was not significantly different between locations (Adults ANOVA, $F_{1,128} = 0.3$; $P = 0.86$).

non-reserve stations in Winter 2004 when topes were observed. These animals constitute a substantial amount of biomass because of their large size even though relatively few animals were observed during the study.

Patterns of abundance and biomass were also determined for California sheephead, *Semicossyphus pulcher* (Labridae) and kelp bass, *Paralabrax clathratus* (Serranidae), two species of recreational/commercial importance. Mean density of California sheephead within the marine reserve was 7.6 ± 0.5 and 5.5 ± 0.4 outside (Figure 3). Overall, density was significantly higher within the marine reserve (ANOVA, $F_{1,128} = 9.8$; $P = 0.002$). This pattern was similar when only adult California sheephead (>30 cm TL) were considered (ANOVA, $F_{1,128} = 17.2$; $P < 0.001$). However, mean density of California sheephead sub-adults and juveniles were not significantly different inside and outside of the marine reserve (ANOVA, $F_{1,128} = 0.3$; $P = 0.86$; Figure 3). Mean biomass of California sheephead was also significantly higher inside of the marine reserve (ANOVA, $F_{1,128} = 35.8$; $P < 0.001$; Figure 5).

Total mean density of kelp bass did not differ significantly between reserve and non-reserve stations (ANOVA, $F_{1,128} = 0.7$; $P = 0.42$; Figure 4). Similar to the pattern for California sheephead, density of kelp bass adults (>30 cm TL) was significantly higher inside the reserve (ANOVA, $F_{1,128} = 4.5$; $P < 0.04$). However, density of juvenile kelp bass did not differ significantly between locations ($F_{1,128} = 0.1$; $P = 0.72$). Biomass of all kelp bass was significantly higher inside the marine reserve (ANOVA, $F_{1,128} = 6.7$; $P = 0.01$; Figure 5).

The mean densities of two resident, non-fished species that were abundant

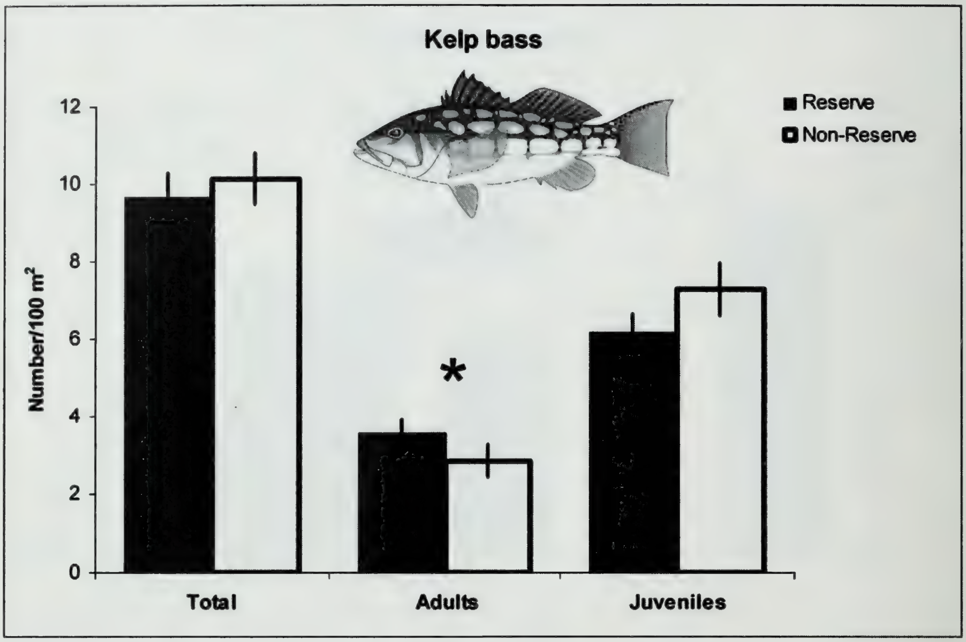

Fig. 4. Mean density of kelp bass inside and outside of a marine reserve at Santa Catalina Island, California. Total density was not significantly higher within the marine reserve (Total ANOVA, $F_{1,128} = 0.7$; $P = 0.42$; Adults ANOVA, $F_{1,128} = 4.5$; $P < 0.04$). Density of juveniles was not significantly different between locations (Adults ANOVA, $F_{1,128} = 0.1$; $P = 0.72$).

enough to permit statistical analysis were also compared. Mean density of garibaldi (*Hypsypops rubicundus*) was significantly higher outside the marine reserve (ANOVA, $F_{1,128} = 1.7$; $P < 0.01$). Density of opaleye (*Girella nigricans*) was also greater outside of the reserve and was marginally significant (ANOVA, $F_{1,128} = 4.0$; $P = 0.05$).

Discussion

This study examined the effect of a small, temperate marine reserve on Santa Catalina Island for the first time. Our results indicated important differences in density and age class distribution of two heavily targeted species in southern California.

Adult density and biomass of both kelp bass and California sheephead were significantly higher inside the marine reserve. Kelp bass larger than 30 cm TL were considered adult, they mature from 22–27 cm TL (Love et al. 1996) and the minimum legal size limit is 30 cm TL in California. Similarly, the minimum legal size for California sheephead is 30 cm TL and they mature between 19–23 cm TL at Santa Catalina Island (Warner 1975). Large adults of both species were common within the reserve while rare outside the reserve boundaries and is similar to observations reported Hobson and Chess (2001) and Erisman and Allen (2006) at Santa Catalina Island. However, the density of sub-adults and juvenile California sheephead did not differ between reserve and non-reserve sites. These findings suggest that differences in adult abundance were unlikely to be the result of poor recruitment or unsuitable habitat at non-reserve sites, and may be attri-

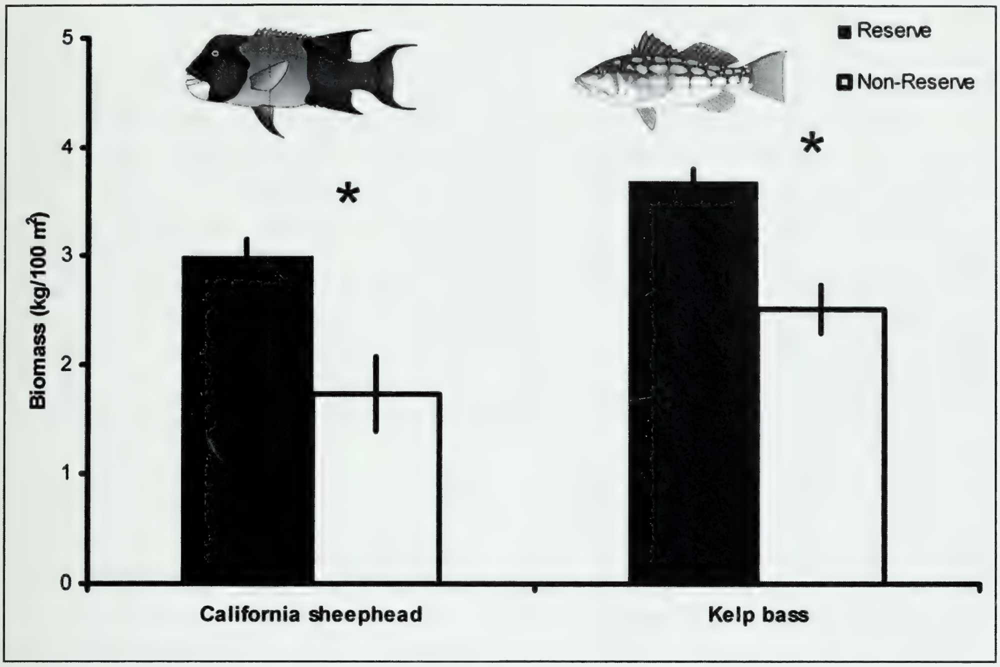

Fig. 5. Biomass of kelp bass in reserve and non-reserve stations at Santa Catalina Island. Biomass of California sheephead was significantly higher inside the marine reserve (ANOVA, $F_{1,128} = 35.8$; $P < 0.001$). Biomass of kelp bass adults was also significantly higher inside the marine reserve (ANOVA, $F_{1,128} = 6.7$; $P = 0.01$).

buted to the removal of adults outside of the marine reserve. While fishing pressure was not directly quantified at the non-reserve sites, both sites were targeted heavily by recreational fishers during the study period while the reserve was well enforced and no fishing or removal of animals was observed (J.T.F personal observation).

California sheephead are monandric, protogynous hermaphrodites that are targeted by anglers, spearfishermen and the recently developed live fishery to supply Asian seafood markets (Adreani et al. 2004). Since males result from sex change of larger, older females, they are naturally rare and thus, may be more vulnerable to exploitation than other species. Furthermore, excess removal of large males may lead to sperm limitation in these populations (Warner et al. 1995) or disrupt normal reproductive behaviors (Adreani et al. 2004). Also, large males exhibit high site fidelity (Topping et al., 2005), which may increase their vulnerability to fishing pressure by hook and line and spearfishers. However, these life history traits may make marine reserves particularly effective at protecting California sheephead stocks because of the territorial behavior and limited home range. Parnell (2005) reported a significant increase in the proportion of large California sheephead males between the San Diego-La Jolla Ecological Reserve and comparable nearby habitats outside the protected area even though this reserve is relatively small (~2.16 km²) and was too small to protect most other species examined (Parnell et al. 2005).

Kelp bass are the most abundant resident mesocarnivorous predators at Santa Catalina Island and are a primary target for southern California recreational fisheries (Quast 1968; Smith and Young 1966; Love et al. 1996). Overall, it appears that the similarity of kelp bass abundance between reserve and non-reserve sites may be deceiving. Density of kelp bass did not differ between reserve and non-reserve sites, however there were important differences in size class and biomass distributions. Biomass and adult density of kelp bass were significantly higher inside the reserve while juveniles were more abundant outside the reserve indicating an increase of large fish within the reserve. This may also be the result of differences in habitat or relief that are confounded in the experimental design of the current study. It is also possible that density dependent recruitment is occurring with kelp bass but was not detected using visual surveys, and the increased adult density within the reserve reduced successful recruitment of juveniles to this area. Density dependent recruitment has been demonstrated previoulsy on numerous, although tropical fishes (Stimson 1990; Tupper and Hunte 1994; Forrester 1995; Steele et al. 1998).

Site fidelity and fine-scale movement patterns were determined for adult kelp bass (Lowe et al. 2003) and California sheephead (Topping et al. 2005) in this marine reserve. Both species had relatively small home ranges compared to the total area of this reserve indicating that the size of this reserve (130,000 m^2). This may be particularly important for these two species. Both species require large adult populations for normal reproductive behavior. California sheephead are haremic spawners (Adreani et al. 2004) and kelp bass form large aggregations during spawning periods (Erisman and Allen 2005) which historically have been targeted heavily by anglers (Erisman and Allen 2006). Recruits of both species were observed frequently during the Fall 2003 in both reserve and non-reserve locations. This lack of difference in the abundance of sub-adults and juveniles of both species argues against recruitment related differences in adult abundance. Additionally, no reserve effect was found when examining other fishes that are not targeted by anglers.

Evidence documenting the effects of marine reserves on the stocks of temperate fishes is limited. Paddack and Estes (2000) examined three marine reserves and adjacent control areas in central California and reported a significant increase in biomass and mean size of kelp rockfish (*Sebastes atrovirens*) in two of the three reserves in the study. As with the current study, the effect was more pronounced in respect to population structure than abundance. Schroeder and Love (2002) also found significant differences in size frequency distribution and species composition of rockfishes in deep water reefs in southern California. Parnell et al. (2005) reported significant increases in density inside the San Diego-La Jolla Ecological Reserve for four species with limited home range: California sheephead, vermillion rockfish (*Sebastes miniatus*), green abalone (*Haliotis fulgens*) and red urchin (*Stronglylocentrotus franscicanus*).

Coral reefs have been examined more intensively and may provide more insight into the possible benefits of reserves to marine ecosystems. Many studies have reported significant increases in density, biomass and mean size of target species inside marine reserves (e.g. Craik 1981; Russ 1985; McCormick and Choat 1987; Polunin and Roberts 1993; Harmelin et al. 1995; Russ and Alcala 1996; Edgar and Barrett 1997; Edgar and Barrett 1999; Willis et al. 2003). Modeling studies have also suggested that marine reserves increase spawing stock biomass per recruit for fishes with high site fidelity (Polacheck 1990; DeMartini 1993). Several studies of reserves in the Florida Keys have examined potential reproductive output of groupers (Serranidae) and reported that most species had spawning potentials less than 20% of that expected for unfished populations (Ault et al. 1997; Bohnsack 1998). However, few studies have attempted to estimate reproductive output per unit area. Paddack and Estes (2000) used density, size structure, and length-fecundity relationships of rockfishes (Scorpaenidae) to estimate reproductive output, which was nearly three times as high for two reserves that had been protected for 12 and 36 years respectively. A third reserve that had been protected for only two years did not show a significant increase in reproductive output. Despite the wealth of evidence outlining possible benefits, marine reserves remain a controversial management tool. This may be due, in part, to the relative lack of empirical versus theoretical evidence and because the majority of studies involved comparisons of single point-in time abundance of target species inside and outside reserve boundaries. Comparisons in this manner may be confounded by habitat, history and/or larval supply differences between reserve and fished locations (Roberts and Polunin 1991; Dugan and Davis 1993). Few studies, including the current investigation, have reported data at both reserve and non-reserve sites before and after implementation of reserves (BACI) that are necessary to unequivocally demonstrate the effects of reserves on marine ecosystems (Underwood 1992; Wantiez et al. 1997).

This marine reserve at Santa Catalina Island is a relatively small, but well enforced area that primarily encompasses a continuous rocky reef, kelp forest habitat. The reserve appears effective in increasing density and biomass of two impacted species that are readily observed and surveyed on SCUBA. Ultimately, these increases may result in increased reproductive output for the species that, in turn, may aid in maintenance of sustainable fisheries. It is also possible that species with similar life history characteristics to the California sheephead or kelp bass may respond similarly to reserve protection and promote sustainable fisheries to a wider range of organisms than were sampled using these methods.

Acknowledgments

We thank the graduate students of the Nearshore Marine Fish Research Program, California State University, Northridge, the Vantuna Research Group at Occidental College, the Aquarium of the Pacific and Wrigley Institute for Environmental Sciences that made this study possible. Also, thanks to Craig Didden, Bridgette Froeschke, Matt Salomon and Casey Terhorst for diving assistance. We also thank two anonymous reviewers for their comments on the manuscript.

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Accepted for publication 29 June 2006.

Bull. Southern California Acad. Sci.
105(3), 2006, pp. 143–144

INDEX TO VOLUME 105

Allen, Larry G., see Eric F. Miller
Allen, Larry G. see John T. Froeschke

Brown, David E., Jorge Cancino, Kevin B. Clark, Myrna Smith, and Jim Yoakum. An Annotated Bibliography of References to Historical Distributions of Pronghorn in Southern and Baja California. 1

Cancino, Jorge, see David E. Brown.
Clark, Kevin B., see David E. Brown
Cooper, Daniel S. Annotated checklist of extirpated, reestablished, and newly-colonized avian taxa of the Ballona Valley, Los Angeles County, California. 91

Dorsey, John H. Densities of Fecal Indicator Bacteria in Tidal Waters of the Ballona Wetlands, Los Angeles County, California. 59

Echavarria-Heras, Héctor A., Elena Solana-Arellano and Ernesto Franco-Viscaíno. The Role of Increased Sea Surface Temperature on Eelgrass Leaf Dynamics: Onset of El Niño as a Proxy for Global Climate change in San Quintin Bay, Baja California. 113

Franco-Viscañno, Ernesto, see Héctor A. Echavarria-Heras,
Froeschke, John T., Larry G. Allen and Daniel J. Pondella II. The Fish Assemblages Inside and Outside of a Temperate Marine Reserve in Southern California. 128

Huddleston, Richard W. and Gary T. Takeuchi. A New Late Miocene Species of Sciaenid Fish, Based Primarily on an *in situ* Otolith from California. 30
Huddleston, Richard W., see Gary T. Takeuchi

Keeley, Jon E., see Jim I. Mead

Lei, Simon A. Interspecific Competition Between *Coleogyne ramosissima* Seedlings and *Bromus rubens*. 76

McGinnis, Thomas W., and see Jim I. Mead
Mead, Jim I., Thomas W. McGinnis, and Jon E. Keeley. A Mid-Holocene Fauna from Bear Den Cave, Sequoia National Park, California. 43
Miller, Eric F. and Larry G. Allen. Observations on the Mating Behavior of Captive Spotted Sand Bass (*Paralabrax maculatofasciatus*). 17

Pondella, Daniel J. II., see John T. Froeschke

Smith, Myrna, see David E. Brown
Solana-Arellano, Elena, see Héctor A. Echavarria-Heras,

Takeuchi, Gary T. and Richard W. Huddleston, A Miocene Chimaeroid Fin Spine from Kern County, California. 85
Takeuchi, Gary T., see Richard W. Huddleston

Yoakum, Jim, see David E. Brown

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Holmes, T. Jr., and S. Speak.1971.Reproductive biology of Myotis lucifugus. J. Mamm., 54:452–458.

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CONTENTS

Annotated checklist of extirpated, reestablished, and newly-colonized avian taxa of the Ballona Valley, Los Angeles County, California. Daniel S. Cooper 91

The Role of Increased Sea Surface Temperature on Eelgrass Leaf Dynamics: Onset of El Niño as a Proxy for Global Climate Change in San Quintín Bay, Baja California. Héctor A. Echavarria-Heras, Elena Solana-Arellano and Ernesto Franco-Viscaíno 113

The Fish Assemblages Inside and Outside of a Temperate Marine Reserve in Southern California. John T. Froeschke, Larry G. Allen and Daniel J. Pondella II 128

Index to Volume 105 143

Cover: Aerial view of western Ballona Valley, Los Angeles County, California.